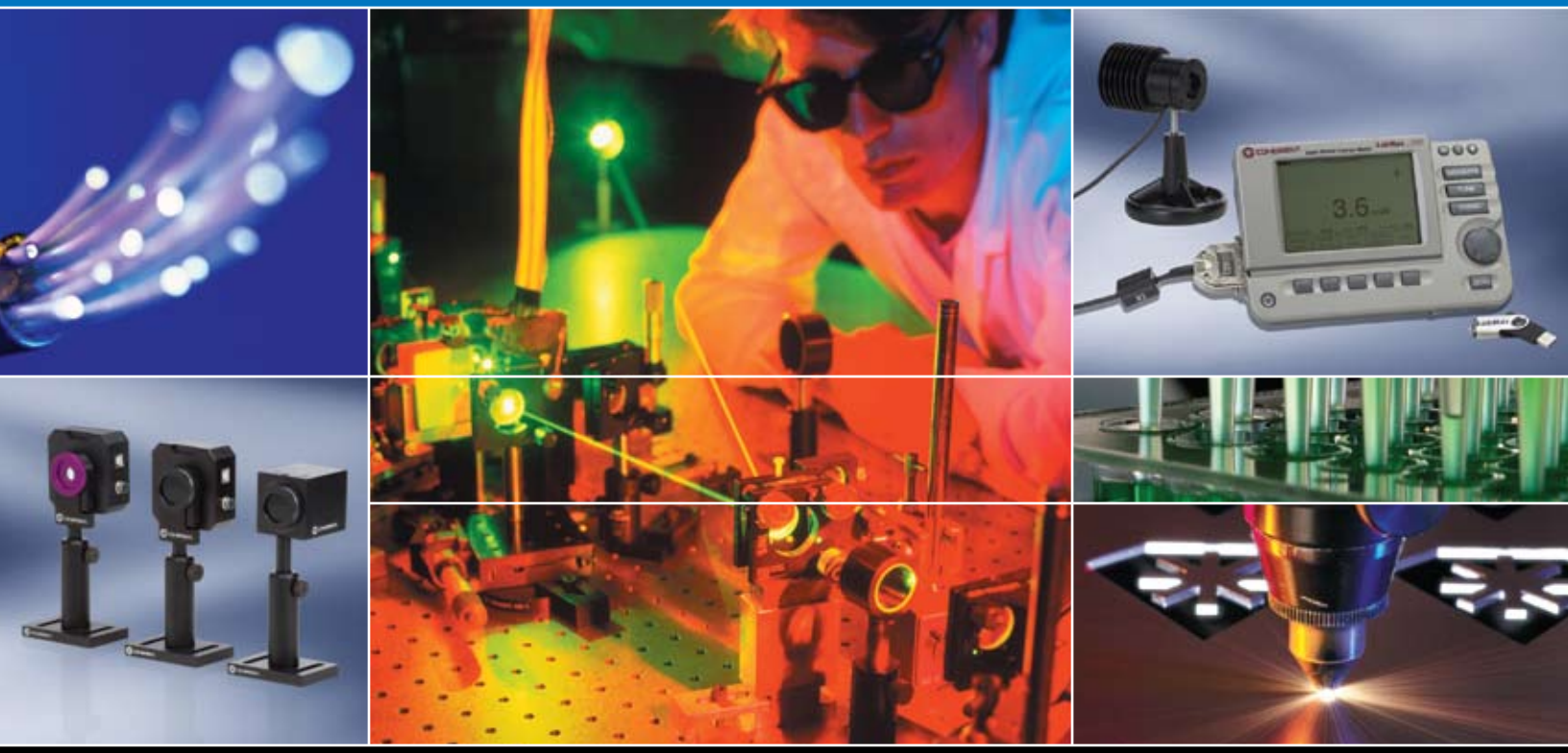
COHERENT®

# Laser Measurement and Control



## 2009 Catalog

Power and Energy Measurement

Custom Power and Energy Solutions

Beam Diagnostics

**Superior Reliability & Performance**

# Coherent Operational Excellence

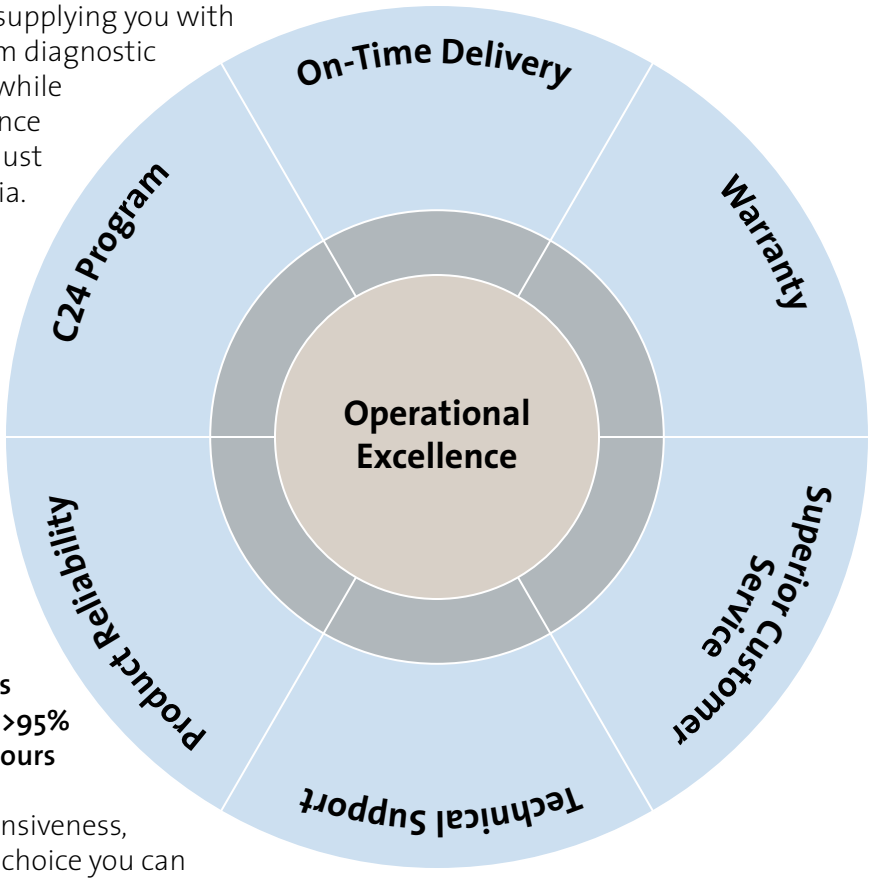
## Operational Experience You Can Count On

For over 40 years, Coherent has been supplying you with the best laser measurement and beam diagnostic equipment available. We realize that while technical specifications greatly influence your purchasing decisions, you also must consider many other important criteria.

In a recent customer survey we found that Product Reliability, Speed of Responsiveness, and Technical Support are the three top criteria when choosing a laser test and measurement supplier. That's why we place as much emphasis on Operational Excellence as we do on technical superiority. Operational Excellence means:

- **Overall product warranty rate <1%**
- **Calibration turnaround time <5 days**
- **On-time delivery for all new orders >95%**
- **Shipment of C24 orders within 24 hours**

For Product Reliability, Speed of Responsiveness, and Technical Support, make the safe choice you can always count on – Coherent.




## The Coherent Laser Measurement Newsletter

To keep informed about our latest laser measurement and beam diagnostics product releases, product upgrades, and special promotions, please sign up for our electronic newsletter at: www.Coherent.com/LMCCatalog.

## We Want You to Know What's New

**New Mailing Address**

Coherent Inc., Portland
27650 SW 95th Avenue
Wilsonville, OR 97070

**New Phone Number**

**Phone:**
**(800) 343-4912 or**
**(408) 764-4042**

**New Fax Number**

**Fax:**
**(503) 454-5727**

**Online:**
**www.Coherent.com**

# Laser Measurement and Control

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### Doing Business with Coherent Inside Back Cover

# New Products

## New to the Catalog



### LaserCam-HR with BeamView Analyzer Software

Pages 57-59

**Features**

- Ease-of-use connectivity
  - High-speed USB 2.0 Interface
  - USB bus-powered low-voltage operation
  - Compact size
- Broad spectral range
  - LaserCam-HR 300 nm to 1100 nm
  - LaserCam-HR-UV DUV to 355 nm
  - LaserCam-InGaAs 900 nm to 1700 nm
- Large dynamic range
- Coherent Adaptive Pixel Technology (CAPT™)
- Digital output through USB 2.0 eliminates the need for a interface card (frame-grabber)
- High-accuracy beam diameter calculations
- Interfaces to BeamView-USB 4.4 (included)

### LabMax-TOP and -TO Power and Energy Meters

**Features**

- Measure power and energy
- Ergonomic design enhances user experience
- Directly compatible with PM Model and LM Model thermopiles
- Directly compatible with EnergyMax sensors
- Displays beam position with LM Model thermopiles
- Logs data to internal memory, directly onto USB flash drive, or to a PC
- USB, RS-232, and GPIB PC interfaces
- Software:
  - LabMax PC applications software
  - LabVIEW instrument driver and ActiveX control

* LabVIEW is registered trademark of National Instruments Corporation.
** ActiveX is a registered trademark of Microsoft Corporation.

Pages 10-12

Position sensing sensors are marked with this quadrant symbol

# New Products

## New to the Catalog

### EnergyMax Pulsed Laser Energy Sensors

Pages 39-49

**Features**

- Unique coatings deliver increased damage threshold, high repetition rate operation and improved mechanical durability
- Operate over the 190 nm to 12 µm range
- Enable pulse energy measurements from 100 nJ to 15J
- Measure single shot to 10 kHz repetition rate
- Spectral compensation characteristics built into each unit
- Automatic temperature compensation
- Signal amplifier for superior signal-to-noise ratio

### J-Power

**Features**

- External low-noise power supply for EnergyMax sensors
- DB25-to-BNC converter
- Allows energy to be measured using oscilloscope
- Internal Li-ion rechargeable battery
- External power supply

Page 49

# Power and Energy Measurement Solutions

## Sensor Technologies



Coherent offers three different sensor technologies (thermopile, semiconductor/optical, and pyroelectric) that address a broad range of measurement parameters and laser characteristics.

## Thermopile

PM Model Thermopiles

LM Model Thermopiles

Thermopile sensors are a great all-purpose technology suitable for many lasers. They are used for measuring CW laser power, average power in pulsed lasers, and are often used to integrate the energy of long pulses.

Thermopile sensors absorb incident laser radiation and convert it into heat. This heat ultimately flows to a heat sink that is held at ambient temperature by either convection-cooling or water-cooling. The temperature difference between the absorber and the heat sink is converted into an electrical signal by a thermocouple junction.

Thermopiles operate across a wide range of input powers, and unlike a semiconductor sensor they will not saturate. The spectral range is dependent upon the coating applied to absorb the laser energy. The coating used on many thermopiles is broadband in nature and is relatively flat from the ultraviolet through the infrared. These sensors have natural response times on the order of several seconds for a low power sensor and up to one minute for a kilowatt sensor. When combined with a Coherent meter a speed-up algorithm provides a much faster response – on the order of seconds for most sensors.

Coherent has two lines of thermopile sensors. The "LM Model" line utilizes a unique thermopile disk in which the thermocouples are split into four quadrants, allowing the sensors to provide beam position information in addition to power measurement. LM Model sensors can be found on pages 22-25. The "PM Model" line incorporates traditional thermopile disks that provide power measurement, found on pages 26-37.

## Semiconductor/Optical

Model OP-2/LM-2

Semiconductor sensors convert incident photons into current that can be measured by our instruments. The photodiodes used in these types of sensors offer high sensitivity and low noise, enabling them to detect very low light levels. They saturate above approximately 1W/cm², so attenuating filters must be used when operating above the milliwatt level.

Photodiodes also have a fast response time, so they are convenient for tuning and peaking lasers. The spectral range is more limited than our other sensor technologies. These devices are also referred to as optical sensors. Semiconductor/optical sensors are limited to measuring CW laser power.

# Power and Energy Measurement Solutions

## Sensor Technologies

## Pyroelectric

EnergyMax - Laser Energy Sensors

Coherent energy sensors use a pyroelectric element to measure the energy in a laser pulse. It does this by producing a large electrical charge for a small change in temperature. The active sensor circuit takes the current from the sensor element and converts it to a voltage that can be measured by a peak detector circuit or a Coherent meter. Pyroelectrics can only be used with pulsed lasers.

Pyroelectric sensors are ideal for measuring the output of pulsed lasers. These devices can be used at repetition rates to 10 kHz and beyond, and can be used to measure laser pulses beyond a Joule.

## Sensor Technology Measurement Range

The following information can help determine which sensor technology to choose based upon the type of laser used and the type of measurement needed.

| Laser Type | Measurement Needed | Power Range | Wavelength Range | Sensor Type |
|---|---|---|---|---|
| CW Laser | Average Power | 10 nW to 50 mW<br>100 µW to >5 kW | 250 nm to 1800 nm<br>0.15 µm to 12 µm | Optical<br>Thermopile |
| Pulsed Laser | Average Power | 100 µW to >5 kW | 0.15 µm to 12 µm | Thermopile |
| Pulsed Laser | Energy Per Pulse | 100 nJ to >10J | 0.15 µm to 12 µm | Pyroelectric |
| Long Pulse Laser (>1 ms) | Single Pulse Integrated Energy | 1 mJ to >300J | 0.15 µm to 12 µm | Thermopile |

The spectral range of these sensor technologies and absorbing coatings are shown in the table below. After identifying a sensor type and coating, the detailed specifications in this catalog (see pages 20 through 48) can be used to select a specific sensor model for your application.

| | Model | Wavelength (nm) | Wavelength (nm) 100 1000 10,000 |
|---|---|---|---|
| **Thermal Sensors** | PowerMax - UV Coating | 150 to 1000 | |
| | PowerMax - Broadband Coating | 190 to 11,000 | |
| | Volume Absorber | 250 to 3000 | |
| **Semiconductor Sensors** | UV | 200 to 400 | |
| | VIS | 400 to 1064 | |
| | IR | 800 to 1800 | |
| **Energy Sensors** | MaxBlack Coating | 190 nm 12,000 | |
| | MaxUV Coating | 190 to 2100 | |
| | Diffuse Metallic Coating | 190 to 2100 | |

After selecting a sensor model, the final step is to identify a meter to measure, display and analyze the sensor output. The information on the next page summarizes the capabilities and features of our meters and lists their compatibility with different sensors. Visit www.Coherent.com/LMC and use our Product Finder to assist you in making your sensor and meter selections.

# Power and Energy Meter Quick Reference Guide

## Meter Features Summary Table



| | FieldMate | FieldMaxII -TOP | FieldMaxII -TO | FieldMaxII -P | LabMax -TOP | LabMax -TO | EPM2000 | Ultima LabMaster | LaserCheck | LaserPAD |
|---|---|---|---|---|---|---|---|---|---|---|
| Page Reference | 15 | 13 | 13 | 13 | 10 | 10 | 16 | 16 | 17 | 16 |
| **Measurement Modes** | | | | | | | | | | |
| CW Power | • | • | • | | • | • | • | • | • | • |
| Avg. Power of Pulsed Lasers | • | • | • | | • | • | • | • | | • |
| Long-Pulse Joules | | • | | | • | • | • | • | | |
| Pulse Energy | | • | | • | • | | • | • | | |
| Max. Rep. Rate (Hz) | | 300 | | 300 | 10,000[1] | | 1000 | 200 | | |
| **Display Types** | | | | | | | | | | |
| Digital Readout | • | • | • | • | • | • | • | • | • | • |
| Analog Needle Tuning | • | | | | | | | | | |
| Graphical Tuning | | • | • | • | • | • | | • | | • |
| Strip Chart/Trending | | | | | • | • | | • | | • |
| **Measurement Analysis Supported** | | | | | | | | | | |
| Beam Position | | | | | • | • | | • | | • |
| Statistics | | • | • | • | • | • | • | • | | • |
| Display Smoothing | | • | • | • | • | • | • | • | | • |
| 2-Channel/Ratiometric | | | | | | | • | • | | |
| **Correction Factors Supported** | | | | | | | | | | |
| Wavelength Correction | • | • | • | • | • | • | • | • | • | • |
| Attenuation Factor | | • | • | • | • | • | • | • | | • |
| **PC Interfaces** | | | | | | | | | | |
| USB | | • | • | • | • | • | | | | • |
| RS-232 | | | | | • | • | • | • | | • |
| GPIB | | | | | •[2] | | • | • | | |
| Analog Output | • | • | • | • | • | • | • | • | | |
| **Electrical Power Options** | | | | | | | | | | |
| Battery (rechargeable) | | • | • | • | • | • | | • | | • |
| Battery (non-rechargeable) | • | | | | | | | | • | |
| AC Powered | • | • | • | • | • | • | • | • | | • |

## Meter and Sensor Compatibility Table

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Power Sensors** | | | | | | | | | | |
| PM Model | • | • | • | | • | • | • | | | |
| PS Model | • | • | • | | • | • | • | | | |
| OP-2 Model | • | • | • | | • | • | | | | |
| LM Model and Beamfinder | •[3] | •[3] | •[3] | | • | • | •[3] | • | | • |
| LM-2 Model | •[3] | •[3] | •[3] | | • | • | | • | | • |
| **Energy Sensors** | | | | | | | | | | |
| EnergyMax | | •[4] | | •[4] | • | | • | | | |

[1] 10,000 Hz sampled; 1000 Hz every pulse.
[2] LabMax-TOP w/GPIB model only.
[3] Compatible when used with Thermal SmartSensor Adapter #1056827.
[4] Our J-50MT-10KHz, J-25MT-10KHz, and J-10MT-10KHz EnergyMax Sensors are not compatible with FieldMaxII-TOP meters. For legacy sensor models not listed, please contact Coherent or your local representative for assistance.

# Power and Energy Measurement Overview

## Compatibility Chart for Our Most Popular Meters and Sensors

### POWER

**Meters**

FieldMate

FieldMaxII

LabMax

**Sensors**

PM & PS Model Thermopile Sensors/OP-2 Model Optical Sensors

Thermal SmartSensor Adapter

LM Model Thermopile Sensors/ LM-2 Model Optical Sensors

Power meters compatible with PM & PS Model Thermopile Sensors

Power meter compatible with LM Model Thermopile Sensors

Power meters need the Thermal SmartSensor Adapter to use LM Model Thermopile Sensors

### ENERGY

**Meters**

FieldMaxII-TOP

LabMaxII-TOP

**Sensors**

EnergyMax Pyroelectric Energy Sensors

# LabMax Meters

## Laser Power and Energy Meters

**Features**

- Measure power and energy
- Ergonomic design enhances user experience
- Directly compatible with PM Model and LM Model thermopiles
- Display beam position with LM Model thermopiles
- Log data to internal memory, directly onto USB flash drive, or to PC
- USB, RS-232, and GPIB PC interfaces
- Software:
  - LabMax PC applications software
  - LabVIEW instrument driver and ActiveX control

**Models**

- LabMax-TOP is compatible with thermopile, optical and pyroelectric (power & energy)
- LabMax-TOP w/GPIB adds IEEE-488 GPIB PC interface (cable included)
- LabMax-TO is compatible with thermopile and optical (power and long-pulse Joules)

LabMax is a versatile meter suitable for anyone who needs to analyze laser output. It analyzes and monitors laser output via onboard data logging. It also supports logging data directly to a USB flash drive, provides enhanced data analysis and statistics, as well as a form factor that allows flexible positioning and viewing angles so it can be used in areas with limited bench space. These meters provide direct compatibility with LM Model and PM Model sensors with no need for adapters.

**Sensor Compatibility**

LabMax displays beam position for quick and accurate setup, and is directly compatible with most Coherent thermal, pyroelectric and semiconductor sensors. These sensors offer wavelength coverage from 190 nm to 12 µm, measure from nW to kW, from nJ to J, and from single shot to 10 kHz.

**Beam Positioning**

The position of the laser beam on the sensor can be displayed by LabMax when using an LM Model thermopile sensor. This makes it easier to align the laser beam during setup, especially for infrared laser beams. There is also a trending feature to monitor the position of the beam over time, and the position data can be logged to a file. Beam position sensors are on pages 22-25.

LM-45 HTD sensor with beam position

**Data Logging**

Data logging of unlimited size can be performed directly to a USB flash drive, and additionally over 400,000 points can be retained onboard the meter itself in flash memory. The meter has a file management system that allows naming and renaming files, auto increments file names for repetitive logging events, folder creation and renaming, and transferring files and folders from the meter storage to a USB flash drive. Data can also be logged to a file with the LabMax PC applications software.

LabMax beam position display

# LabMax Meters

## Laser Power and Energy Meters

**Ergonomic Design**
LabMax features a large, backlit graphical display with an ergonomic interface with easily accessible buttons for all features and modes. The Measure, Tune, and Trend modes are directly accessible via front panel buttons.

Front panel buttons

**Flexible Positioning**
The LabMax display and meter can be positioned at many different angles within the limited bench space typically available in a laser lab, while still making the display easy to view.

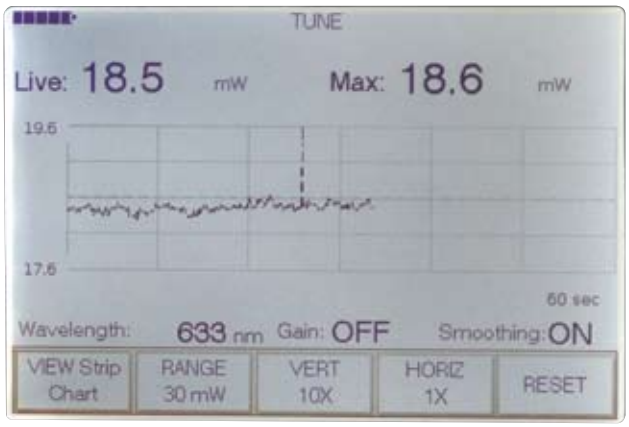
**Additional Inputs/Outputs**
In addition to PC interfacing, LabMax also includes an analog output with user-selectable voltages of 0 to 1V, 2V, or 4V. Pyroelectric triggering can be achieved with an external trigger input or an internal trigger that is user-adjustable from 2% to 20% percent of full-scale range.

**Measurement Analysis**
LabMax meters contain several advanced analysis capabilities, including:

Onboard statistics – mean, minimum, maximum, standard deviation, range, three stability parameters, as well as missed pulses. Users can also select which statistical parameters to display, up to six at a time.

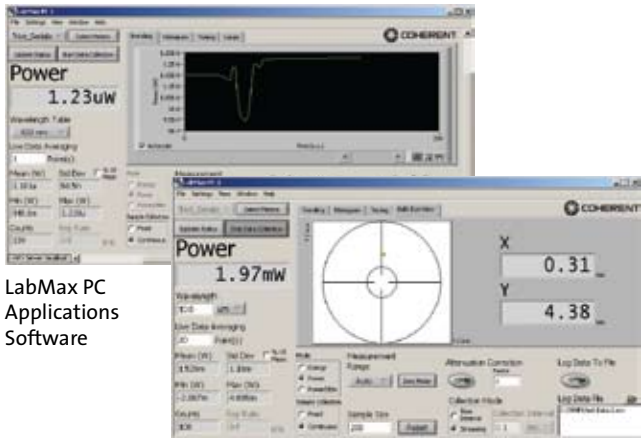
Trend charting – trend chart with statistical display and the ability to log data to a file.

Digital tuning indicators – horizontal bar and trend chart formats with peak indicators.



LabMax Tune Chart

**PC Interfacing and Applications Software**
Data can also be analyzed directly on a PC through USB, RS-232, or GPIB connections, or by logging data to a USB flash drive attached directly to the meter. Installable applications software and LabVIEW drivers are provided to support PC interfacing.



LabMax PC Applications Software

# LabMax Meters

## Laser Power and Energy Meters



**Device Specifications**

| Model | LabMax-TOP w/GPIB | LabMax-TOP | LabMax-TO |
|---|---|---|---|
| Measurement Resolution | 0.1 % of full-scale | | |
| Displayable Resolution | 3 or 4 digits pyroelectric; 3, 4, or 5 digits thermopile and optical (user-selectable) | | 3, 4, or 5 digits (user-selectable) |
| Measurement Range | Sensor dependent (reference sensor specifications) | | |
| Accuracy | | | |
| Digital Meter | ±1.0% ±2LSD | | |
| System | Meter accuracy + sensor accuracy | | |
| Analog Output (%) | ±1.0 | | |
| Uncertainty (%) | ±1.0 | | |
| Power Sampling Rate (Hz) | 10 | | |
| Maximum Repetition Rate (Hz) | 10,000 sampling (1000 Hz every pulse) | | |
| Minimum Positional Resolution (mm) | 0.1 | | |
| Display | 112 x 78 mm backlight graphic LCD, 480 x 320 pixels. Adjustable contrast and viewing angle | | |
| Measurement Analysis | Min., max., mean, range, std. dev., dose, stability; trending, tuning, beam position | | |
| Computer Interface | GPIB, USB and RS-232 | USB and RS-232 | |
| Pulse Triggering | Internal and external (selectable) | | – |
| Analog Output (VDC) | 0 to 1, 2, or 4 VDC (selectable) | | |
| Analog Output Update Rate | Up to 1000 Hz for pyroelectric; 10 Hz for thermopile and optical | | 10 Hz |
| Temperature | | | |
| Operating Range | 5 to 40°C (41 to 104°F) | | |
| Storage Range | -20 to 70°C (-68 to 158°F) | | |
| Instrument Power | 90 to 260 VAC, 50/60 Hz | | |
| Instrument Batteries | 4400 mAH Rechargeable Li-ion Pack | | |
| Compliance | CE, RoHS, WEEE | | |
| Dimensions (H x W x D) | 152 x 229 x 53 mm (6.0 x 9.0 x 2.1 in.) | | |
| Weight | 1.25 kg (2.8 lbs.) | | |
| Front Panel | | | |
| PWR | Turn meter on and off | | |
| ZERO | Reset ambient offset for thermal and optical sensors | | |
| MEASURE | Main measure mode including statistics | | |
| TUNE | View tuning features | | |
| TREND | Display measured values over a period of time and log data to file | | |
| SETUP | Setup meter parameters | | |
| HELP | Onboard context sensitive help - available from any screen | | |
| BACKLIGHT | Toggle backlight on and off | | |
| KNOB | Turn knob to change settings; press the knob to save settings | | |
| Left Side Panel | USB flash drive port<br>USB PC interface port<br>RS-232 PC interface port<br>DB25 sensor port<br>Power jack | | |
| Rear Panel | Analog output | | |
| | External trigger input | | – |
| | GPIB PC interface port | – | |
| Part Number* | 1104620 | 1104622 | 1104619 |

* Meter supplied with 4400 mAH Li-ion battery, AC power adapter, power cord, 1.8-meter USB cable, RS-232 adapter, USB flash drive, RCA-to-BNC adapters, user manual, software and driver CD, soft carrying case, and certificate of calibration. LabMax-TOP w/GPIB also includes a GPIB cable.

# FieldMaxII Meters

## Laser Power Meter and Energy Meters

FieldMaxII-TOP Power and Energy Meter

FieldMaxII-TO Power Meter

**Features**

- Measure energy of pulsed lasers up to 300 pps
- Large, backlight LCD display
- Compatible with thermopile, optical, and pyroelectric sensors
- Simulated analog-like movement for laser tuning
- USB interface with FieldMaxII PC applications software, LabVIEW instrument driver and ActiveX control
- Area function for density measurements (J/cm² or W/cm²)

**Models**

- FieldMaxII-TOP is compatible with thermopile, optical and pyroelectric sensors (power & energy)
- FieldMaxII-TO is compatible with thermopile and optical (power only)
- FieldMaxII-P is compatible with pyroelectric (energy only)

FieldMaxII is an affordable, versatile, easy-to-use digital power and energy meter platform designed for a variety of applications ranging from field service to production test applications.

FieldMaxII features a large, easy-to-read backlit LCD and an intuitive user interface offering button-driven control for simple operation. The meter supports onboard analysis of mean, min., max., and standard deviation statistics. It can measure power from nW to kW, and pulse energy from nJ to J at up to 300 pps. In addition, long-pulse Joules energy measurements can be made on the FieldMaxII-TOP model when using thermopiles.

The meter includes a USB PC interface as well as an analog output. The FieldMaxII PC applications software supports trend charting, tuning, statistics, and logging data to a file. A LabVIEW instrument driver with ActiveX control is provided to support custom software developments.

## FieldMaxII PC Application

**Features**

- USB PC Interface
- FieldMaxII PC is completely open-source so that you can use it to help develop your own customized applications
- Multiple meters can be run on a single PC – useful for final test and burn-in applications
- Meters can be operated remotely via host interface and included drivers
- Software features:
  - Measure, Tune, Trend displays
  - Statistics
- LabVIEW instrument driver and ActiveX DLL server included

# FieldMaxII Meters

## Laser Power and Energy Meters



**Device Specifications**

| Model | FieldMaxII-TOP | FieldMaxII-TO | FieldMaxII-P |
|---|---|---|---|
| Function | Power and energy | Power | Energy |
| Measurement Resolution | 0.1% of full-scale | | |
| Measurement Range | Sensor dependent - reference sensor specifications | | |
| Accuracy | | | |
| Digital Meter | ±1.0% ±2LSD | | |
| System | Meter accuracy + sensor accuracy | | |
| Analog Output (%) | ±1.0 | | |
| Uncertainty (%) | ±1.0 | | |
| Power Sampling Rate (Hz) | 10 | 10 | – |
| Maximum Pulse Rep. Rate (Hz) | 300 | – | 300 |
| Display | 58 x 73 mm , fixed-segment LCD with backlight | | |
| Digital Tuning Indicator | 100 msec time constant | | |
| Statistics | Mean, max., min., standard deviation | | |
| PC Interface | USB 1.1 | | |
| Analog Output | 0 to 1, 2, or 5 VDC (selectable) | | |
| Internal Trigger | 2 to 20% of full-scale, selectable | – | 2% to 20% of full-scale, selectable |
| Temperature | | | |
| Operating Range | 5 to 40°C (41 to 104°F) | | |
| Storage Range | -20 to 70°C (-68 to 158°F) | | |
| Instrument Power | 100 to 240 VAC, 50/60 Hz | | |
| Instrument Batteries | Rechargeable NiMH battery pack | | |
| Compliance | CE, RoHS, WEEE | | |
| Dimensions (H x W x D) | 200 x 100 x 40 mm, (7.87 x 3.94 x 1.57 in.) | | |
| Weight | 1.0 kg (2.2 lbs.) | | |
| Front Panel | | | |
| PWR | Toggle power switch and backlight | | |
| HZ | Display rep. rate | – | Display rep. rate |
| J/W | Select Joules or Watts mode | – | – |
| ZERO | Reset ambient offset for thermal and optical sensors | | Zero stats |
| AUTO | Engage auto-ranging with power sensors | | – |
| STAT | Display statistics: mean, max., min., standard deviation | | |
| AVG | Engage display averaging | | |
| λ | Enter wavelength and engage wavelength compensation | | |
| ATTEN | Enter attenuation factor and engage attenuation | | |
| AREA | J/cm² (fluence) W/cm² (power density) | W/cm² (power density) | J/cm² (fluence) |
| HOLD | – | Holds displayed values on screen | – |
| TRIG | Select trigger level with energy sensors | – | Select trigger level with energy sensors |
| SETUP / LOCAL | Set and enter button/Takes local control of meter back from PC | | |
| ARROW KEYS | Manually control range; Select Stats parameter; Select and change numerical values | | |
| Left Side Panels | Power jack | | |
| | USB PC interface port | | |
| | Analog output | | |
| Right Side Panels | DB25 sensor port | | |
| Part Number* | 1098580 | 1098579 | 1098581 |

* Meter supplied with NiMH rechargeable battery pack, power cord, AC adapter, USB cable (1.8m), RCA-to-BNC analog output adapter, user manual, installation CD with FieldMaxII PC and drivers, soft carrying case, and certificate of calibration.

# FieldMate

## Laser Power Meter

**Features**

- **Analog needle for tuning**
- **Large digital LCD display**
- **Compatible with thermopile and optical sensors**
- **Wavelength compensation**
- **Analog output**
- **Compact and portable**
- **AC and battery power**
- **Auto ranging**

FieldMate combines a digital display and analog meter with sophisticated digital processing to enable rapid, sensitive laser adjustment. This meter also offers an economical way of measuring laser power when advanced data analysis is not necessary.

**Device Specifications**

| Model | FieldMate |
|---|---|
| Power Resolution | 0.1% of full-scale for all ranges in the 10s scale<br>0.3% of full-scale for all ranges in the 3s scale |
| Measurement Range | Sensor dependent (reference sensor specifications) |
| Accuracy | |
| Digital Meter | ±1.0% ±2LSD |
| System | Meter accuracy + sensor accuracy |
| Analog Meter (%) | ±3.0 |
| Analog Output (%) | ±1.0 |
| Uncertainty (%) | ±1.0 |
| Power Sampling Rate | 20 Hz (thermopile and optical) |
| Display | 26 x 89 mm, custom fixed-segment LCD |
| Analog Needle | |
| Scale | 0 to 10 (100 divisions), 0 to 3 (60 divisions) |
| Response | 80 ms time constant |
| Analog Output | |
| Voltage | 0 to 2 VDC |
| Update Rate | 20 times/sec. |
| Temperature | |
| Operating Range | 5 to 40°C (41 to 104°F) |
| Storage Range | -20 to 70°C (-68 to 158°F) |
| Instrument Power | 100 to 240 VAC, 50/60 Hz |
| Instrument Batteries | Two 9V alkaline batteries |
| Compliance | CE, RoHS, WEEE |
| Dimensions (H x W x D) | 193 x 117 x 46 mm, (7.6 x 4.6 x 1.8 in.) |
| Weight | 0.8 kg (1.8 lbs.) |
| Front Panel | |
| PWR | Toggle power |
| ZERO | Ambient offset |
| AUTO | Engage auto-ranging |
| λ | Enter wavelength compensation |
| ARROW KEYS | Manually control range; select and change numerical values |
| Left Side Panel | Power jack<br>Analog output<br>DB-25 sensor port |
| Part Number* | 1098297 |

* Meter supplied with two alkaline 9V batteries, power cord, AC power adapter, RCA-to-BNC analog output adapter, user manual, and certificate of calibration.

# EPM2000

## Dual-Channel Power and Energy Meter

**Features**

- Measures power and energy
- Repetition rate to 1000 pps
- Dual-channel with ratio measurement
- External trigger input
- RS-232 and GPIB computer interfaces
- Analog output
- LabVIEW driver

| Part Number | Description |
|---|---|
| 0011-5140 | EPM2000 |

# Ultima LabMaster 2-Channel

## Dual-Channel Power and Energy Meter

**Features**

- Measures power and energy
- Dual-channel with ratio measurement
- Displays beam position with LM Model thermopiles
- Trend charting
- RS-232 and GPIB PC interfaces
- Analog output
- RMS noise measurement with LM-2 sensors

| Part Number | Description |
|---|---|
| 33-0613-000 | Ultima LabMaster |

# LaserPAD

## Laser Power Meter

**Features**

- PC-based power meter system
- Displays beam position with LM Model thermopiles
- LaserPAD PC applications software included
- RS-232 and USB PC interface
- Compatible with LM Model thermopiles and optical sensors
- OEM software tools CD for embedded applications
- LabVIEW drivers

| Part Number | Description |
|---|---|
| 1008557 | LaserPAD |

# LaserCheck

## Laser Power Meter

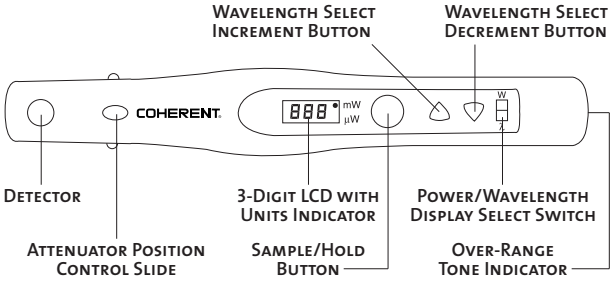
### Features

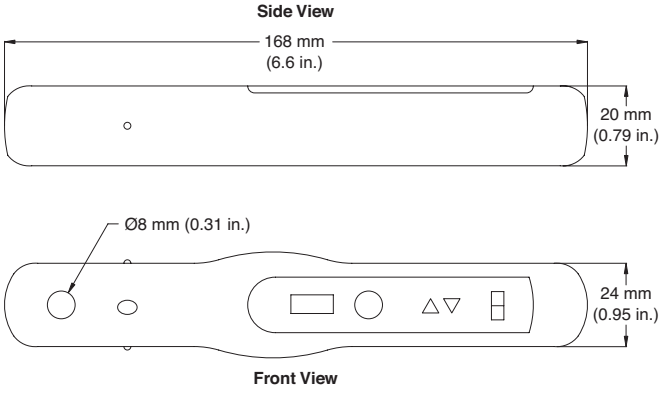
- Hand-held laser power meter
- Measurement range: 0.5 µW to 1W
- Wavelength range: 400 to 1064 nm
- User-selectable spectral compensation
- Auto-ranging with peak sample and hold

**Device Specifications**

| Model | LaserCheck |
|---|---|
| Active Area Diameter (mm) | 8 |
| Spectral Range (nm) | 400 to 1064 |
| Accuracy (%) | ±5 |
| Measurement Range | |
| without Attenuator | 0.5 µW to 10 mW |
| with Attenuator | 10 mW to 1W |
| Display Power Ranges | 9.99 µW to 999 mW |
| Minimum Power Resolution (µW) | 0.01 |
| Maximum Power Density | |
| without Attenuator | 0.5 W/cm² |
| with Attenuator | 30 W/cm² |
| Display | 3-digit LCD display with power unit indicator |
| Compliance | CE, WEEE, RoHS |
| Dimensions (H x W x D) | 168 x 24 x 20 mm (6.6 x 0.9 x 0.7 in.) |
| Weight | 44 g (0.09 lbs.) |
| Part Number (RoHS) | 1098293 |

LaserCheck



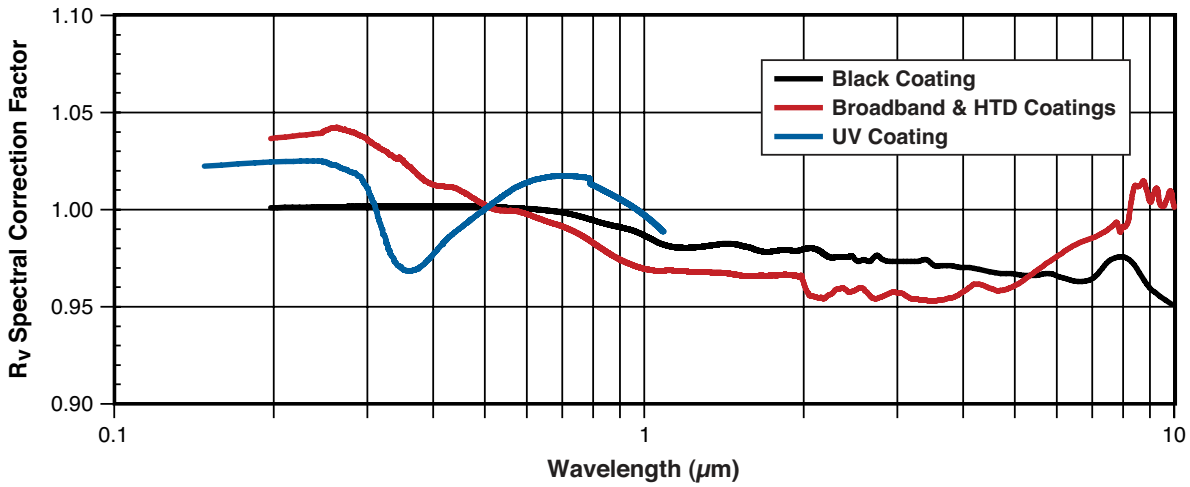
# Power Sensors Introduction

## Introduction and Selection Charts



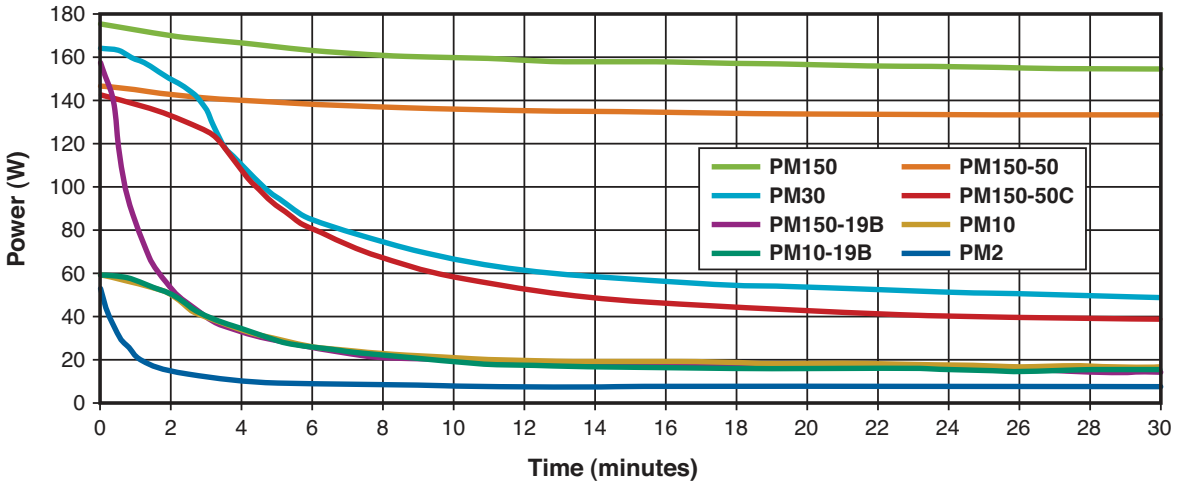
Coherent uses three primary coatings to capture the incident radiation on our thermal sensors. The specifications for each sensor list which coating is used. Typical wavelength ranges and response curves for these coatings are shown in the chart below. Each sensor contains a spectral curve generated from reflectance measurements taken with spectrometers. The reflectance data are converted into a wavelength compensation look-up table that is loaded into the sensor. This data is accessed by selecting a wavelength of operation in the meters.

$R_V$ Spectral Correction for Thermal Sensors (normalized to 514 nm)




Many of our thermal sensors can measure power at levels greater than the maximum power rating for limited amounts of time. The following chart outlines how much power can be measured over a range of exposure times (Note: Water-cooled sensors are power-rated in air-cooled mode in this chart).

Exposure Limit vs. Power



# Power Sensors Introduction

## Long-Pulse Energy Measurement with a Thermopile

Models PM10-19C, PM150-50C and PM150-50XC

**Application Example 1**

| | |
|---|---|
| Laser Pulse Width | 50 ms |
| Maximum Energy | 10J |
| Solution | Choose a PM10 |

**Application Example 2**

| | |
|---|---|
| Laser Pulse Width | 300 ms |
| Maximum Energy | 80J |
| Solution | Choose a PM150 or PM150-50C* |

* Specific sensor choice depends upon aperture and mechanical constraints.

Thermopile sensors are most commonly used for average power measurements on pulsed and CW lasers. Thermopiles are also capable of integrating long pulse widths. This allows the thermopile to measure the energy of single pulses between 1 millisecond and 10 seconds in length, and with energies from millijoules to hundreds of Joules. Long-pulse measurement is only possible when the thermopiles are used in conjunction with LabMax-TOP, LabMax-TO, or FieldMaxII-TOP meters.

This ability to integrate relatively long laser pulses with a thermopile is necessary when the laser pulse width exceeds the maximum pulse width rating of pyroelectric sensors. Pyroelectric sensors are typically limited to maximum pulse widths in the millisecond range. When the pulse width exceeds milliseconds, a thermopile is a good solution.

A good "rule of thumb" for using a thermopile for this type of measurement is to compare the maximum pulse energy you need to measure with the maximum power rating of a sensor (maximum power ratings can be found in the Power Sensor Summary Specifications on pages 20 to 21 or in the detailed product specifications contained on pages 22 to 37).

Common applications for this type of measurement are in the medical field, especially skin resurfacing and hair removal, and in material processing applications such as laser welding. These laser systems often utilize high-energy diode lasers that have large beam sizes and relatively long pulses. A detector like the PM150-50C is ideal for these measurements. It features a large 50 mm aperture size, can handle pulse energies up to 150J, and can be used air-cooled for single pulse energy measurements (a PM150-50C will normally need to be water-cooled for continuous power measurements).

Using a LabMax power/energy meter expands the range of long-pulse Joule measurements down into the low millijoule level when used with thermopiles such as the PS10, PS10Q, PS19, and PS19Q sensors.

Long-pulse measurements are limited to single pulses in order to achieve the most accurate measurements.

# Power Sensors Introduction

## Summary of Specifications



| Part Number | Description | Wavelength Range (µm) | Power Min. | Power Max. | Power Resolution | Long-Pulse Energy Range (J) | Detector Diameter (mm) | Detector Coating | Detector Type | Calibration Wavelength (nm) | Calibration Uncertainty (±%) | Connector |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **High-Sensitivity Semiconductor Sensors (to 50 mW)** | | | | | | | | | | | | |
| 1098401 | OP-2 UV | 0.25 to 0.4 | 10 nW | 30 mW | 1 nW | – | 6.0 | – | Silicon | – | 8 | OP DB-25 |
| 1098313 | OP-2 VIS | 0.4 to 1.064 | 10 nW | 50 mW | 1 nW | – | 7.9 | – | Silicon | – | 5 | OP DB-25 |
| 1098416 | OP-2 IR | 0.8 to 1.8 | 10 nW | 10 mW | 1 nW | – | 5.0 | – | Germanium | – | 4.5 | OP DB-25 |
| 1098390 | LM-2 UV | 0.25 to 0.4 | 10 nW | 30 mW | 1 nW | – | 6.0 | – | Silicon | – | 8 | LM DB-25 |
| 1098298 | LM-2 VIS | 0.4 to 1.064 | 10 nW | 50 mW | 1 nW | – | 7.9 | – | Silicon | – | 5 | LM DB-25 |
| 1098342 | LM-2 IR | 0.8 to 1.55 | 10 nW | 10 mW | 1 nW | – | 5.0 | – | Germanium | – | 4.5 | LM DB-25 |
| **High-Sensitivity Thermopile Sensors (to 2W)** | | | | | | | | | | | | |
| 1098350 | PS10 | 0.3 to 11.0 | 100 µW | 1W | 10 µW | 0.001 to 1 | 10 | Black | – | 514 | 1 | PM DB-25 |
| 1098400 | PS10Q | 0.3 to 2.0 | 100 µW | 1W | 10 µW | 0.001 to 1 | 10 | Black | – | 514 | 1 | PM DB-25 |
| 1098413 | PS19 | 0.3 to 11.0 | 100 µW | 1W | 10 µW | 0.001 to 1 | 19 | Black | – | 514 | 1 | PM DB-25 |
| 1098341 | PS19Q | 0.3 to 2.0 | 100 µW | 1W | 10 µW | 0.001 to 1 | 19 | Black | – | 514 | 1 | PM DB-25 |
| 1098336 | PM3 | 0.3 to 11.0 | 500 µW | 2W | 50 µW | – | 19 | Black | – | 514 | 1 | PM DB-25 |
| 1098419 | PM3Q | 0.3 to 2.0 | 500 µW | 2W | 50 µW | – | 10 | Black | – | 514 | 1 | PM DB-25 |
| **Air-Cooled Thermopile Sensors (to 150W)** | | | | | | | | | | | | |
| 1098329 | PM2 | 0.19 to 11.0 | 10 mW | 2W | 1 mW | 0.5 to 2 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098457 | PM2X | 0.15 to 1.0 | 10 mW | 2W | 1 mW | 0.5 to 2 | 19 | UV | – | 514 | 1 | PM DB-25 |
| 1097901 | PM10 | 0.19 to 11.0 | 10 mW | 10W | 1 mW | 0.5 to 10 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098423 | PM10X | 0.15 to 1.0 | 10 mW | 10W | 1 mW | 0.5 to 10 | 19 | UV | – | 514 | 1 | PM DB-25 |
| 1098314 | PM30 | 0.19 to 11.0 | 100 mW | 30W | 10 mW | 0.5 to 50 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098498 | PM30X | 0.15 to 1.0 | 100 mW | 30W | 10 mW | 0.5 to 50 | 19 | UV | – | 514 | 1 | PM DB-25 |
| 1098483 | PM100-19C | 0.19 to 11.0 | 300 mW | 100W | 30 mW | 1 to 100 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098407 | PM150 | 0.19 to 11.0 | 300 mW | 150W | 30 mW | 1 to 150 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098398 | PM150-50 | 0.19 to 11.0 | 300 mW | 150W | 30 mW | 1 to 150 | 50 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098455 | PM150X | 0.15 to 1.0 | 300 mW | 150W | 30 mW | 1 to 150 | 50 | UV | – | 514 | 1 | PM DB-25 |
| **Water-Cooled Thermopile Sensors (to 300W)** | | | | | | | | | | | | |
| 1098397 | PM10-19C | 0.19 to 11.0 | 10 mW | 10W | 1 mW | 0.5 to 10 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098444 | PM150-19C | 0.19 to 11.0 | 300 mW | 150W | 30 mW | 1 to 150 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098412 | PM150-50C | 0.19 to 11.0 | 300 mW | 150W | 30 mW | 1 to 150 | 50 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098443 | PM150-50XC | 0.15 to 1.0 | 300 mW | 150W | 30 mW | 1 to 150 | 50 | UV | – | 514 | 1 | PM DB-25 |
| 1141474 | PM300 | 0.19 to 11.0 | 1W | 300W | 0.1W | – | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| **Fan-Cooled Thermopile Sensors (to 300W)** | | | | | | | | | | | | |
| 1098480 | PM200F-19 | 0.19 to 11.0 | 1W | 200W | 100 mW | 1 to 200 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098472 | PM200F-50 | 0.19 to 11.0 | 1W | 200W | 100 mW | 1 to 200 | 50 | Broadband | – | 514 | 1 | PM DB-25 |
| 1113493 | PM200F-50X | 0.15 to 1.0 | 1W | 200W | 100 mW | 1 to 200 | 50 | UV | – | 514 | 1 | PM DB-25 |
| 1098509 | PM300F-19 | 0.19 to 11.0 | 1W | 300W | 100 mW | 1 to 300 | 19 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098417 | PM300F-50 | 0.19 to 11.0 | 1W | 300W | 100 mW | 1 to 300 | 50 | Broadband | – | 514 | 1 | PM DB-25 |
| 1098481 | PM300F-50X | 0.15 to 1.0 | 1W | 300W | 100 mW | 1 to 300 | 50 | UV | – | 514 | 1 | PM DB-25 |

# Power Sensors Introduction

## Summary of Specifications

| Part Number | Description | Wavelength Range (µm) | Power Min. (W) | Power Max. (W) | Power Resolution (W) | Long-Pulse Energy Range (J) | Detector Diameter (mm) | Detector Coating | Calibration Wavelength (nm) | Calibration Uncertainty (±%) | Connector |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **High-Power Water-Cooled Thermopile Sensors (to 5 kW)** | | | | | | | | | | | |
| 1098392 | PM1K | 0.19 to 11.0 | 100 | 1000 | 1 | – | 50 | Broadband | 1064 | 5 | PM DB-25 |
| 1098462 | PM3K | 0.19 to 11.0 | 100 | 3000 | 1 | – | 50 | Broadband | 1064 | 5 | PM DB-25 |
| 1098454 | PM5K | 0.19 to 11.0 | 100 | 5000 | 1 | – | 50 | Broadband | 1064 | 5 | PM DB-25 |
| **Large-Area High-Power Water-Cooled Thermopile Sensors (to 5 kW)** | | | | | | | | | | | |
| 1098490 | PM1K-100 | 0.19 to 11.0 | 100 | 1000 | 1 | – | 100 | Broadband | 1064 | 5 | PM DB-25 |
| 1098506 | PM3K-100 | 0.19 to 11.0 | 100 | 3000 | 1 | – | 100 | Broadband | 1064 | 5 | PM DB-25 |
| 1098461 | PM5K-100 | 0.19 to 11.0 | 100 | 5000 | 1 | – | 100 | Broadband | 1064 | 5 | PM DB-25 |
| 1098505 | PM5K-200 | 0.19 to 11.0 | 100 | 5000 | 1 | – | 200 | Broadband | 1064 | 5 | PM DB-25 |
| **Position-Sensing Air-Cooled Thermopile Sensors (to 200W)** | | | | | | | | | | | |
| 1098328 | LM-3 | 0.25 to 10.6 | 0.01 | 3 | 0.001 | 0.5 to 10 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098304 | LM-10 | 0.25 to 10.6 | 0.01 | 10 | 0.001 | 0.5 to 10 | 16 | HTD | 10600 | 5 | LM DB-25 |
| 1098456 | LM-20 | 0.25 to 10.6 | 0.1 | 20 | 0.01 | 0.5 to 10 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098320 | LM-45 | 0.25 to 10.6 | 0.1 | 45 | 0.01 | 0.5 to 10 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098346 | LM-100 | 0.25 to 10.6 | 0.1 | 100 | 0.01 | 0.5 to 10 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098394 | LM-150 FS | 0.25 to 10.6 | 0.1 | 150 | 0.01 | 0.5 to 10 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098452 | LM-150 LS | 0.25 to 10.6 | 0.1 | 150 | 0.01 | 0.5 to 10 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098450 | LM-200 220V | 0.25 to 10.6 | 0.1 | 200 | 0.01 | 0.5 to 100 | 19 | HTD | 10600 | 5 | LM DB-25 |
| 1098440 | LM-200 110V | 0.25 to 10.6 | 0.1 | 200 | 0.01 | 0.5 to 100 | 19 | HTD | 10600 | 5 | LM DB-25 |
| **Position-Sensing Water-Cooled Thermopile Sensors (to 5 kW)** | | | | | | | | | | | |
| 1098409 | LM-1000 | 0.25 to 10.6 | 100 | 1000 | 1 | – | 38 | Broadband | 10600 | 5 | LM DB-25 |
| 1098437 | LM-2500 | 0.25 to 10.6 | 100 | 2500 | 1 | – | 55 | Broadband | 10600 | 5 | LM DB-25 |
| 1098421 | LM-5000 | 0.25 to 10.6 | 100 | 5000 | 1 | – | 55 | Broadband | 10600 | 5 | LM DB-25 |
| **High-Peak-Power Thermopile Sensors (to 30W)** | | | | | | | | | | | |
| 1098338 | PM10V1 | 0.25 to 3.0 | 0.01 | 10 | 0.001 | – | 19 | Volume Absorber | 514 | 1 | PM DB-25 |
| 1098429 | PM30V1 | 0.25 to 3.0 | 0.1 | 30 | 0.01 | – | 19 | Volume Absorber | 514 | 1 | PM DB-25 |
| 1098414 | PM30V1Q | 0.25 to 3.0 | 0.1 | 30 | 0.01 | – | 19 | Volume Absorber | 514 | 1 | PM DB-25 |
| **Off-the-Shelf OEM Power Sensors (to 1 kW)** | | | | | | | | | | | |
| 1098334 | PM10-19A | 0.19 to 11.0 | 0.1 | 10 | 0.01 | – | 19 | Broadband | 514 | 1 | 4-pin connector |
| 1098343 | PM10-19B | 0.19 to 11.0 | 0.1 | 10 | 0.01 | – | 19 | Broadband | 514 | 1 | BNC-terminated |
| 1098418 | PM150-19A | 0.19 to 11.0 | 0.3 | 150 | 0.03 | – | 19 | Broadband | 514 | 1 | 4-pin connector |
| 1098321 | PM150-19B | 0.19 to 11.0 | 0.3 | 150 | 0.03 | – | 19 | Broadband | 514 | 1 | BNC-terminated |
| 1098510 | PM150-50A | 0.19 to 11.0 | 0.3 | 150 | 0.03 | – | 50 | Broadband | 514 | 1 | 4-pin connector |
| 1098415 | PM150-50B | 0.19 to 11.0 | 0.3 | 150 | 0.03 | – | 50 | Broadband | 514 | 1 | BNC-terminated |
| 1098441 | PM150-50XB | 0.15 to 1.0 | 0.3 | 150 | 0.03 | – | 50 | UV | 514 | 1 | BNC-terminated |
| 1098333 | PM1K-36B | 0.19 to 11.0 | 100 | 1000 | 1 | – | 36 | Broadband | 1064 | 5 | BNC-terminated |
| 1098427 | BeamFinder | 0.25 to 10.6 | 100 | 1000 | 1 | – | 35 | Broadband | 10600 | 5 | LM DB-25 |

# Beam Position Sensing Thermopile Sensors

## 10 mW to 45W

Models LM-3, LM-10, LM-45

**Features**

- **Spectrally flat from 0.19 to 11 µm**
- **10 mW to 100 mW resolution**
- **16 mm to 19 mm apertures**
- **FC and SMA fiber connectors available (see page 38)**

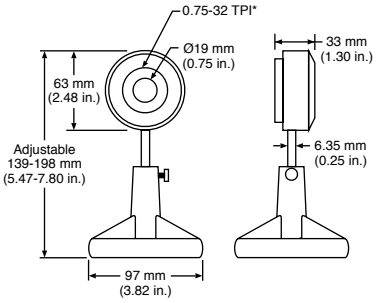
Use with LabMax, Ultima, or LaserPAD (see pages 10-16)

These unique thermopiles incorporate a quadrant thermopile disk that enables them to sense the position of the beam on the detector surface. This information is displayed by meters such as LabMax. All Coherent products which incorporate this position sensing technology are identified with the logo shown on the right.

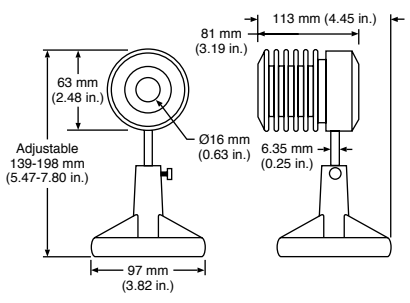
**Device Specifications**

| Model | LM-3 | LM-10 | LM-45 |
|---|---|---|---|
| Wavelength Range (µm) | | 0.25 to 10.6 | |
| Power Range | 10 mW to 3W | 10 mW to 10W | 100 mW to 45W |
| Long-Pulse Joules Range (J) | | 0.5 to 10 | |
| Resolution (mW) | | 10 | 100 |
| Max. Power Density | | 6 kW/cm² | |
| Max. Energy Density | | 0.5 J/cm², 1064 nm, 10 ns | |
| Detector Coating | | HTD | |
| Detector Diameter (mm) | 19 | 16 | 19 |
| Dimensions (mm) | Ø63 X 33 (2.4 x 1.2 in.) | Ø63 X 81 (2.4 x 3.1 in.) | Ø64 X 86 (2.5 x 3.3 in.) |
| Calibration Uncertainty (%) | | ±2 | |
| Calibration Wavelength (µm) | | 10.6 | |
| Cooling Method | | Air-cooled | |
| Cable Type | | LM DB-25 | |
| Cable Length (m) | | 1.8 | |
| Part Number | 1098328 | 1098304 | 1098320 |

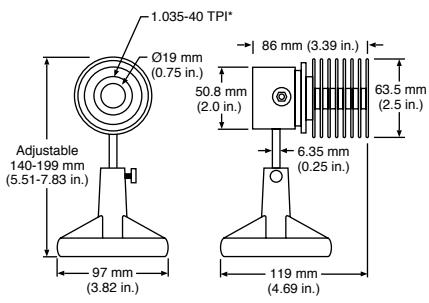
**LM-3**




**LM-10**




**LM-45**




* Threads per inch

# Beam Position Sensing Thermopile Sensors

## 100 mW to 200W

Models LM-100, LM-200

**Features**

- **Spectrally flat from 0.19 to 11 µm**
- **10 mW resolution**
- **19 mm apertures**
- **FC and SMA fiber connectors available (see page 38)**

The LM-100 sensor is convectively-cooled for powers up to 100W. The LM-200 sensor is fan-cooled and is available in 110 VAC and 220 VAC configurations.

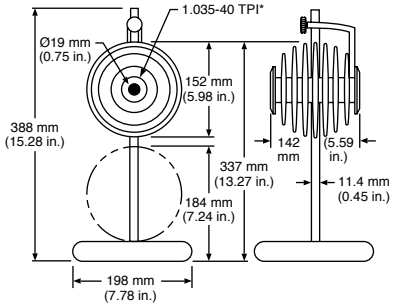
Use with LabMax, Ultima, or LaserPAD (see pages 10-16)



**Device Specifications**

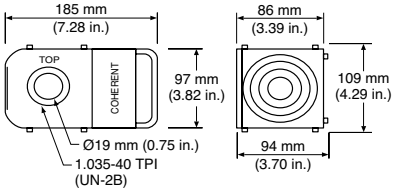
| Model | LM-100 | LM-200 |
|---|---|---|
| Wavelength Range (µm) | 0.25 to 10.6 | |
| Power Range (water-cooled) | 100 mW to 100W | 100 mW to 200W |
| Long-Pulse Joules Range (J) | 0.5 to 10 | |
| Resolution (mW) | 10 | |
| Max. Power Density | 6 kW/cm² | |
| Max. Energy Density | 0.5 J/cm², 1064 nm, 10 ns | |
| Detector Coating | HTD | |
| Detector Diameter (mm) | 19 | |
| Dimensions (mm) | Ø152 x 142 (5.9 x 5.5 in.) | 185 x 94 x 109 (7.3 x 3.7 x 4.3 in.) |
| Calibration Uncertainty (%) | ±2 | ±5 |
| Calibration Wavelength (µm) | 10.6 | |
| Cooling Method | Air-cooled | Fan-cooled |
| Cable Type | LM DB-25 | |
| Cable Length (m) | 1.8 | |
| Part Number | 1098346 | 1098440 (110VAC)<br>1098450 (220 VAC) |

**LM-100**




*Threads per inch

**LM-200**



# Beam Position Sensing Thermopile Sensors

## 100 mW to 150W

Models LM-150LS, LM-150FS, LM-20

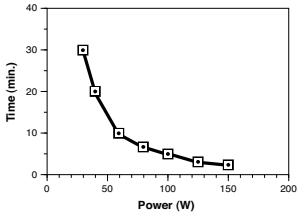
**Features**

- Spectrally flat from 0.19 to 11 µm
- 10 mW to 100 mW resolution
- 19 mm apertures

The LM-20 is designed for embedded use and must be mounted on a heat sink. The LM-150 FS and LS sensors are designed for intermittent operation.

Use with LabMax, Ultima, or LaserPAD (see pages 10-16)

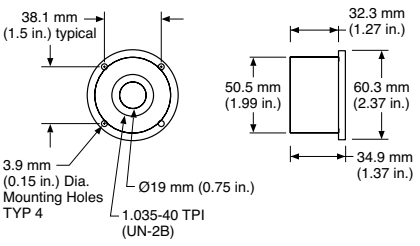
LM-150 FS and LS Power Duration



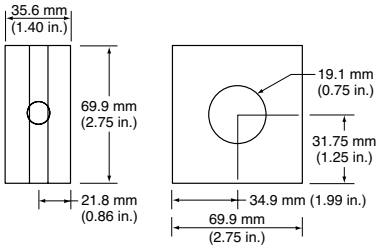

**Device Specifications**

| Model | LM-20 | LM-150 LS | LM-150 FS |
|---|---|---|---|
| Wavelength Range (µm) | | 0.25 to 10.6 | |
| Power Range | 100 mW to 20W | 100 mW to 150W | 100 mW to 150W |
| Long-Pulse Joules Range (J) | | 0.5 to 10 | |
| Resolution (mW) | | 10 | |
| Max. Power Density | | 6 kW/cm² | |
| Max. Energy Density | | 0.5 J/cm², 1064 nm, 10 ns | |
| Detector Coating | | HTD | |
| Detector Diameter (mm) | | 19 | |
| Dimensions (mm) | Ø60 x 32 (2.4 x 1.3 in.) | 70 x 70 x 36 (2.8 x 2.8 x 1.4 in.) | Ø89 X 38 (3.5 x 1.4 in.) |
| Calibration Uncertainty (%) | | ±2 | |
| Calibration Wavelength (µm) | | 10.6 | |
| Cooling Method | Conductive-cooled | Air-cooled | |
| Cable Type | | LM DB-25 | |
| Cable Length (m) | | 1.8 | |
| Part Number | 1098456 | 1098452 | 1098394 |

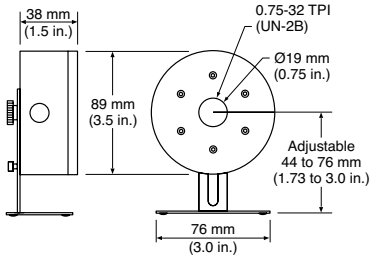
**LM-20**




**LM-150 LS**



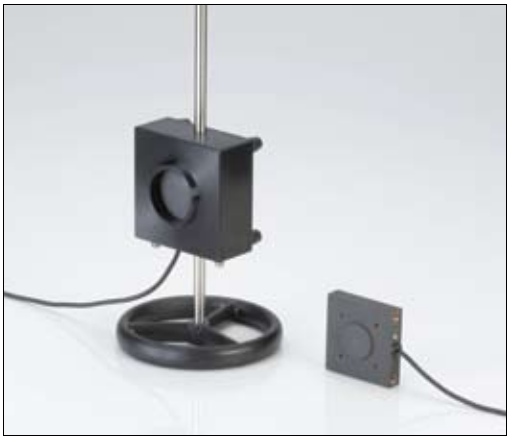

**LM-150 FS**




* Threads per inch

# Beam Position Sensing Thermopile Sensors

## 100W to 5 kW



Models LM5000, BeamFinder

**Features**

- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1W resolution**
- **35 mm to 55 mm apertures**

Use with LabMax, Ultima, or LaserPAD (see pages 10-16)

These kilowatt thermopile sensors are water-cooled for measuring output over 100W and are excellent for use with $CO_2$ and Nd:YAG lasers.

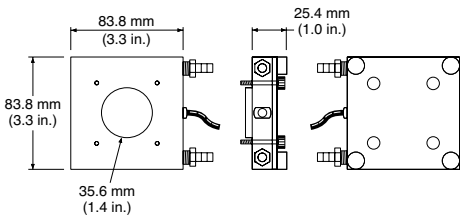
Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details).

**Device Specifications**

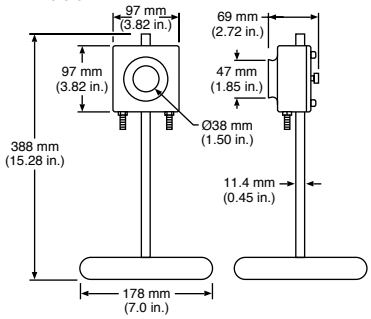
| Model | BeamFinder | LM-1000 | LM-2500 | LM-5000 |
|---|---|---|---|---|
| Wavelength Range (µm) | 0.3 to 10.6 | 0.25 to 10.6 | | |
| Power Range (W) | 100 to 1000 | | 100 to 2500 | 100 to 5000 |
| Resolution (W) | 1 | | | |
| Max. Power Density[1] | 1 to 2.5 kW/cm² | | | |
| Max. Energy Density | 0.5 J/cm², 1064 nm, 10 ns | | | |
| Detector Coating | H | | | |
| Active Area Diameter (mm) | 35 | 38 | 55 | |
| Dimensions (mm) | 84 x 84 x 25.4 (3.3 x 3.3 x 1.0 in.) | 97 x 97 x 69 (3.8 x 3.8 x 2.7 in.) | 122 x 122 x 69 (4.8 x 4.8 x 2.7 in.) | |
| Calibration Uncertainty (%) | ±5 | | | |
| Calibration Wavelength (µm) | 10.6 | | | |
| Cooling Method | Water-cooled | | | |
| Cable Type | LM DB-25 | | | |
| Cable Length (m) | 6 | | | |
| Part Number | 1098427 | 1098409 | 1098437 | 1098421 |

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

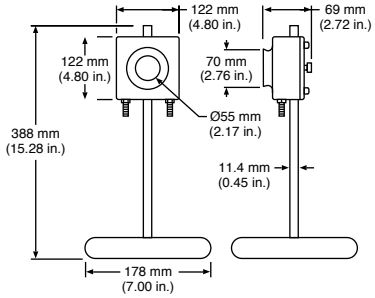
**BeamFinder**




**LM-1000**




**LM-2500/LM-5000**



# High-Sensitivity Optical Power Sensors

## 10 nW to 50 mW, CW

Model OP-2/LM-2

**Features**

- **Si, Ge photodiodes**
- **Spectral range: 250 nm to 1800 nm**
- **Fiber-optic connector (optional, see page 38)**
- **1000:1 attenuator for measurement to 5W (optional, see page 38)**

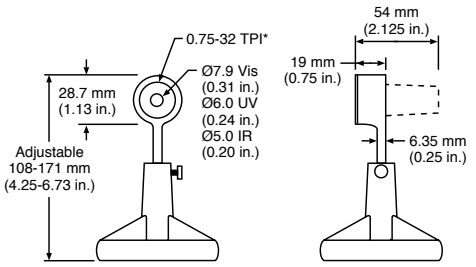
These high-sensitivity semiconductor sensors are ideal for CW laser measurements in the nW to low mW level. They typically saturate in the 10 to 50 mW level, depending upon the model. For linear operation up to a maximum of 5 Watts, an optional 1000:1 attenuator is used.

**Device Specifications**

| Model | OP-2/LM-2 UV | OP-2/LM-2 VIS | OP-2/LM-2 IR |
|---|---|---|---|
| Detector Material | Silicon | | Germanium |
| Wavelength Range (µm) | 0.25 to 0.4 | 0.4 to 1.06 | 0.8 to 1.80/0.8 to 1.5[1] |
| Power Range | 10 nW to 30 mW | 10 nW to 50 mW | 10 nW to 10 mW |
| Resolution (nW) | 1 | | |
| Active Area Diameter (mm) | 6 | 7.9 | 5 |
| Dimensions (mm) | Ø29 x 54 (1.1 x 2.1 in.) | | |
| Calibration Uncertainty (%) | ±8 | ±5 | ±4.5 |
| Calibration Wavelength (nm) | Monochromator calibration across wavelength range | | |
| Cooling Method | Air-cooled | | |
| Connector Type | OP DB-25/LM DB-25 | | |
| Cable Length (m) | 1.8 | | |
| Part Number | | | |
| OP-2 | 1098401 | 1098313 | 1098416 |
| LM-2 | 1098390 | 1098298 | 1098342 |

[1] OP-2 IR and LM-2 IR have different spectral ranges.

**OP-2 UV/OP-2 VIS/OP-2 IR**
**LM-2 UV/LM-2 VIS/LM-2 IR**




* Threads Per Inch

**Accessories**

1000:1 Attenuator

Fiber-Optic Connector Adapters

# High-Sensitivity Thermopile Power Sensors

## 100 µW to 2W

Models PS19Q, PS19, PS10, PM3

**Features**

- **Thermally stabilized designs**
- **Spectrally flat from 0.3 µm to 11 µm**
- **10 µW resolution**
- **Fiber-optic connectors (optional, see page 38)**

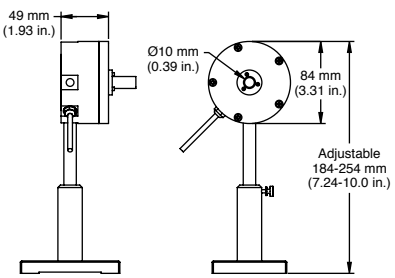
The PS10 and PS19 model sensors are thermally stabilized, amplified thermopile power sensors with a broad spectral response, high sensitivity, and a large active area. These sensors are ideal for measuring laser diodes, HeNe and HeCd lasers, and small ion lasers. The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation. The light tube can be removed and replaced by FC or SMA fiber connectors (see Accessories - page 38). Where optimum stability is required, specify the PS10Q or PS19Q, which include a wedged quartz window for applications from 0.3 to 2.0 µm. The quartz window more effectively eliminates thermal background radiation and the effects of air currents.

**Device Specifications**

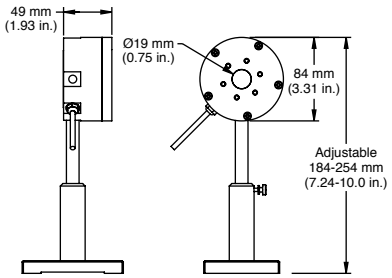
| Model | PS10[2] | PS10Q | PS19 | PS19Q | PM3[2] | PM3Q |
|---|---|---|---|---|---|---|
| Wavelength Range (µm) | 0.3 to 11 | 0.3 to 2 | 0.3 to 11 | 0.3 to 2 | 0.3 to 11 | 0.3 to 2 |
| Power Range | 100 µW to 1W | | | | 500 µW to 2W | |
| Resolution (µW) | 10 | | | | 50 | |
| Max. Thermal Drift[1] | ±40 µW | ±20 µW | ±400 µW | ±20 µW | ±1 mW | ±500 µW |
| Max. Avg. Power Density | 0.5 kW/cm² | | | | | |
| Max. Pulse Energy Density | 50 mJ/cm², 10 ns , 1064 nm | | | | | |
| Response Time (sec.) | 2 | | | | | |
| Detector Coating | Black | | | | | |
| Quartz Filter Window | No | Yes | No | Yes | No | Yes |
| Active Area Diameter (mm) | 10 | | 19 | | 19 | 10 |
| Dimensions (mm) | Ø84 x 49 (3.3 x 1.9 in.) | | | | Ø63 x 36 (2.4 x 1.4 in.) | |
| Calibration Uncertainty (%) | ±1 | | | | | |
| Calibration Wavelength (nm) | 514 | | | | | |
| Cooling Method | Air-cooled | | | | | |
| Cable Type | PM DB-25 | | | | | |
| Cable Length (m) | 2 | | | | | |
| Part Number | 1098350 | 1098400 | 1098413 | 1098341 | 1098336 | 1098419 |

[1] Power stability over 30 minutes in a typical lab environment.
[2] Light tube supplied with PS10 and PM3 models only.

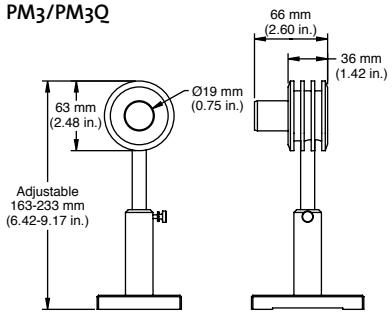
**PS10/PS10Q**




**PS19/PS19Q**




**PM3/PM3Q**



# Air-Cooled Thermopile Sensors

## 10 mW to 30W

Models PM2, PM10, PM30

**Features**

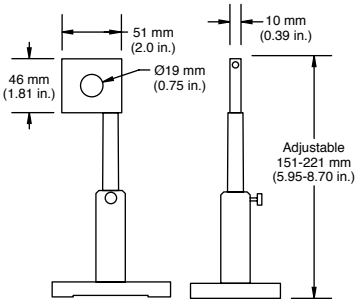
- **Convective air-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1 to 10 mW resolution**
- **19 mm aperture**

These thermopile sensors are used to measure CW and pulsed lasers from 10 mW up to 30W average power output. These sensors are able to dissipate heat via convection cooling, which makes them convenient to use.

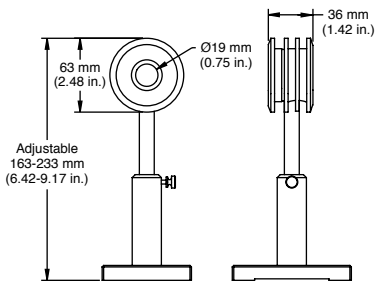
**Device Specifications**

| Model | PM2 | PM10 | PM30 |
|---|---|---|---|
| Wavelength Range (µm) | | 0.19 to 11 | |
| Power Range | 10 mW to 2W | 10 mW to 10W | 100 mW to 30W |
| Long-Pulse Joules Range (J) | 0.5 to 2 | 0.5 to 10 | 0.5 to 50 |
| Max. Intermittent Power (<5 min.)(W) | 5 | 30 | 50 |
| Resolution (mW) | | 1 | 10 |
| Max. Power Density | | 26 kW/cm² | |
| Max. Energy Density | | 0.6 J/cm², 1064 nm, 10 ns | |
| Response Time (sec.) | | 2 | |
| Detector Coating | | Broadband | |
| Active Area Diameter (mm) | | 19 | |
| Dimensions (mm) | 46 x 51 x 10 (1.8 x 2.0 x 0.3 in.) | Ø63 x 36 (2.4 x 1.4 in.) | Ø101 x 56 (3.9 x 2.2 in.) |
| Calibration Uncertainty (%) | | ±1 | |
| Calibration Wavelength (nm) | | 514 | |
| Cooling Method | | Air-cooled | |
| Cable Type | | PM DB-25 | |
| Cable Length (m) | | 2 | |
| Part Number | 1098329 | 1097901 | 1098314 |

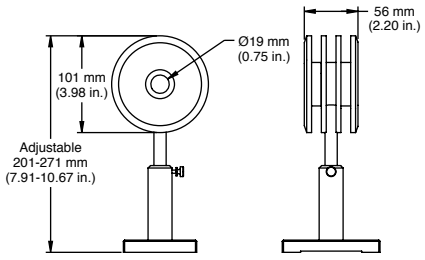
**PM2**




**PM10**




**PM30**



# Air-Cooled Thermopile Sensors

## 300 mW to 150W

Models PM150-50, PM150, PM100-19C

**Features**

- Convective air-cooled
- Spectrally flat from 0.19 µm to 11 µm
- 30 mW resolution
- 19 mm and 50 mm apertures

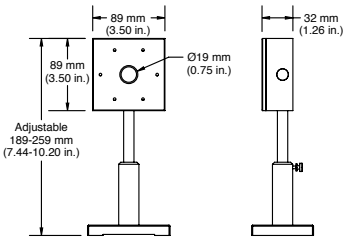


**Device Specifications**

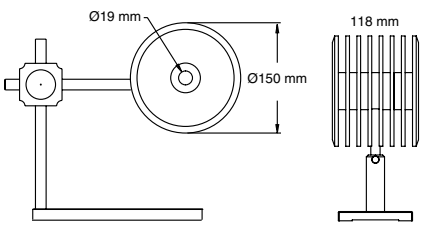
| Model | PM100-19C[1] | PM150 | PM150-50 |
|---|---|---|---|
| Wavelength Range (µm) | 0.19 to 11 | | |
| Power Range | 300 mW to 100W | 300 mW to 150W | |
| Long-Pulse Joules Range (J) | 1 to 100 | 1 to 150 | |
| Max. Intermittent Power (<5 min.)(W) | 100 | 300 | |
| Resolution (mW) | 30 | | |
| Max. Power Density | 26 kW/cm² | | |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | |
| Response Time (sec.) | 2 | | 5 |
| Detector Coating | Broadband | | |
| Active Area Diameter (mm) | 19 | | 50 |
| Dimensions (mm) | 89 x 89 x 32 (3.5 x 3.5 x 1.2 in.) | Ø150 x 118 (5.9 x 4.6 in.) | |
| Calibration Uncertainty (%) | ±1 | | |
| Calibration Wavelength (nm) | 514 | | |
| Cooling Method | Air-cooled | | |
| Cable Type | PM DB-25 | | |
| Cable Length (m) | 2 | | |
| Part Number | 1098483 | 1098407 | 1098398 |

[1] This sensor is designed for intermittent use only.

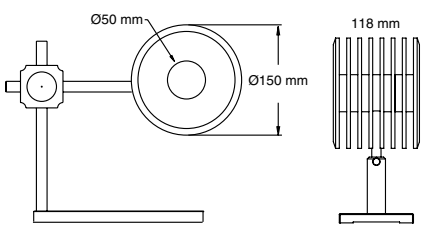
**PM100-19C**




**PM150**




**PM150-50**



# Water-Cooled Thermopile Sensors

## 10 mW to 300W

Models PM300, PM150-50C, PM150-19C

**Features**

- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1 mW to 100 mW resolution**
- **19 mm and 50 mm apertures**

These compact sensors are ideal in tight spaces, but must be water-cooled in order to achieve their full power specification during continuous operation. They can also be mounted to a heat sink or used standalone for intermittent use. Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details).

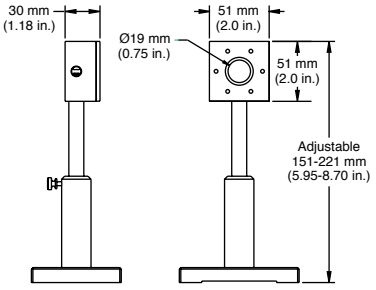
OEM versions of these sensors with passive and amplified outputs can be found on page 53.

**Device Specifications**

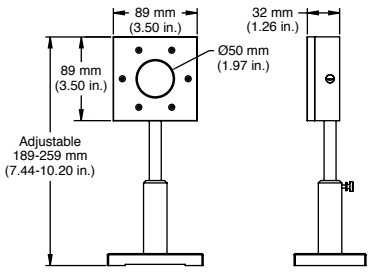
| Model | PM10-19C | PM150-19C | PM150-50C | PM300 |
|---|---|---|---|---|
| Wavelength Range (µm) | 0.19 to 11 | | | |
| Power Range (water-cooled) | 10 mW to 10W | 300 mW to 150W | | 1 W to 300W |
| Max. Intermittent Power (<5 min.) (W) | 5W[1] | 20W[1] | 80W[1] | 450W[2] |
| Long-Pulse Joules Range (J) | 0.5 to 10 | 1 to 150 | | – |
| Resolution (mW) | 1 | 30 | | 100 |
| Max. Power Density | 26 kW/cm² | | | |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | | |
| Response Time (sec.) | 2 | | 5 | |
| Detector Coating | Broadband | | | |
| Active Area Diameter (mm) | 19 | | 50 | 19 |
| Dimensions (mm) | 51 x 51 x 30 (2.0 x 2.0 x 1.1 in.) | | 89 x 89 x 32 (3.5 x 3.5 x 1.2 in.) | Ø76 x 56 (2.9 x 2.2 in.) |
| Calibration Uncertainty (%) | ±1 | | | |
| Calibration Wavelength (nm) | 514 | | | |
| Cooling Method | Water-cooled | | | |
| Cable Type | PM DB-25 | | | |
| Cable Length (m) | 2 | | | |
| Part Number | 1098397 | 1098444 | 1098412 | 1141474 |

[1] This intermittent power rating is for when the sensor is used without water-cooling.
[2] This intermittent power rating is for when the sensor is used with water-cooling.

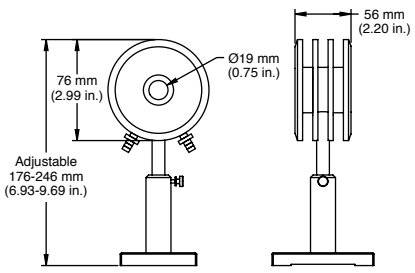
**PM10-19C/PM150-19C**




**PM150-50C**




**PM300**



# Fan-Cooled Thermopile Sensors

## 1W to 300W

Models PM200F-50, PM300F-50

**Features**

- **Fan-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **100 mW resolution**
- **19 mm and 50 mm apertures**

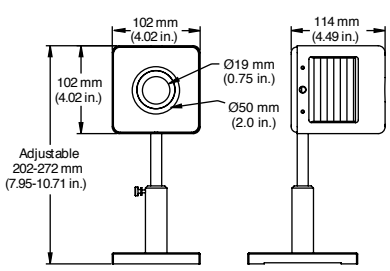
Fan-cooled sensors are an excellent choice for measuring high-power lasers when water-cooling is not possible. A compact power supply provides the 12 VDC required to power the fan.



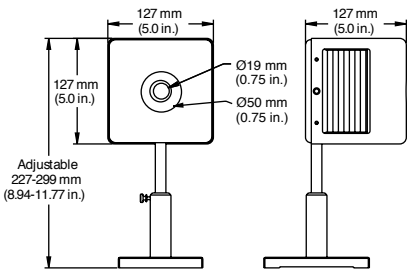
**Device Specifications**

| Model | PM200F-19 | PM200F-50 | PM300F-19 | PM300F-50 |
|---|---|---|---|---|
| Wavelength Range (µm) | 0.19 to 11 | | | |
| Power Range (W) | 1 to 200 | | 1 to 300 | |
| Long-Pulse Joules Range (J) | 1 to 200 | | 1 to 300 | |
| Max. Intermittent Power (<5 min.)(W) | 300 | | 450 | |
| Resolution (mW) | 100 | | | |
| Max. Power Density | 26 kW/cm² | | | |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | | |
| Response Time (sec.) | 2 | 5 | 2 | 5 |
| Detector Coating | Broadband | | | |
| Active Area Diameter (mm) | 19 | 50 | 19 | 50 |
| Dimensions (mm) | 102 x 102 x 114 (4.0 x 4.0 x 4.4 in.) | | 127 x 127 x 127 (5 x 5 x 5 in.) | |
| Calibration Uncertainty (%) | ±1 | | | |
| Calibration Wavelength (nm) | 514 | | | |
| Cooling Method | Fan-cooled | | | |
| Cable Type | PM DB-25 | | | |
| Cable Length (m) | 2 | | | |
| Part Number | 1098480 | 1098472 | 1098509 | 1098417 |

**PM200F-19/PM200F-50**




**PM300F-19/PM300F-50**



# Water-Cooled Thermopile Sensors

## 100W to 5 kW

Model PM1K

**Features**

- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1W resolution**
- **50 mm apertures**

These water-cooled sensors are used to measure lasers over 300W average power output. They are excellent choices for measuring $CO_2$ and Nd:YAG lasers. Larger-area versions are available on the next page.

Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details).

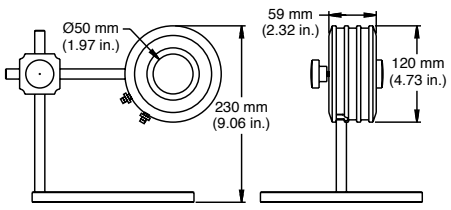
**Device Specifications**

| Model | PM1K | PM3K | PM5K |
|---|---|---|---|
| Wavelength Range (µm) | | 0.19 to 11 | |
| Power Range (W) | 100 to 1000 | 100 to 3000 | 100 to 5000 |
| Max. Intermittent Power (<5 min.)(W)[1] | 3000 | 5000 | 10000 |
| Resolution (W) | | 1 | |
| Max. Power Density[2] | | 1 to 10 kW/cm² | |
| Max. Energy Density | | 0.6 J/cm², 1064 nm, 10 ns | |
| Response Time (sec.) | | 30 | |
| Detector Coating | | Broadband | |
| Active Area Diameter (mm) | | 50 | |
| Dimensions (mm) | | Ø120 x 59 (4.7 x 2.3 in.) | |
| Calibration Uncertainty (%) | | ±5 | |
| Calibration Wavelength (nm) | | 1064 | |
| Cooling Method | | Water-cooled | |
| Cable Type | | PM DB-25 | |
| Cable Length (m) | | 2 | |
| Part Number | 1098392 | 1098462 | 1098454 |

[1] Intermittent power levels may be sustainable for longer than 5 minutes when used with lasers with large diameter, non-Gaussian beam profiles. Monitor closely for coating damage if used longer than five minutes at higher powers.

[2] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

**PM1K/PM3K/PM5K**



# Large-Area High-Power Water-Cooled Thermopile Sensors

## 10 mW to 5 kW

Models PM5K-200, PM3K-100

**Features**

- **Water-cooled**
- **100 mm and 200 mm apertures**
- **Spectrally flat from 0.19 µm to 11 µm**

These large-area, water-cooled thermopiles are designed to measure large laser diode stacks and arrays, and other high-power divergent sources.

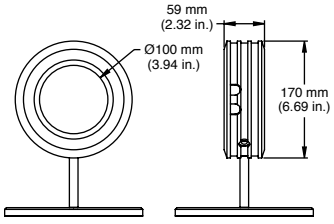


**Device Specifications**

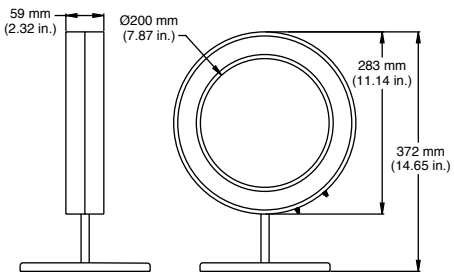
| Model | PM1K-100 | PM3K-100 | PM5K-100 | PM5K-200 |
|---|---|---|---|---|
| Wavelength Range (µm) | 0.19 to 11 | | | |
| Power Range (W) | 100 to 1000 | 100 to 3000 | 100 to 5000 | 100 to 5000 |
| Max. Intermittent Power (<5 min.)(W) | 1500 | 4000 | 7500 | 7500 |
| Resolution (W) | 1 | | | |
| Max. Power Density[1] | 1 to 10 kW/cm² | | | |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | | |
| Response Time (sec.) | 45 | | | |
| Detector Coating[1] | Broadband | | | |
| Detector Diameter (mm) | 100 | | | 200 |
| Dimensions (mm) | Ø170 X 59 (6.6 x 2.3 in.) | | | Ø283 x 59 (11.1 x 2.3 in.) |
| Calibration Uncertainty (%) | ±5 | | | |
| Calibration Wavelength (nm) | 1064 | | | |
| Cooling Method | Water-cooled | | | |
| Cable Type | PM DB-25 | | | |
| Cable Length (m) | 2 | | | |
| Part Number | 1098490 | 1098506 | 1098461 | 1098505 |

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

**PM1K-100/PM3K-100/PM5K-100**




**PM5K-200**



# High-Peak-Power Thermopile Sensors

## 10 mW to 30W

Models PM30V1Q, PM30V1, PM10V1

**Features**

- **Volume absorber**
- **5.0 J/cm² @ 1064 nm**

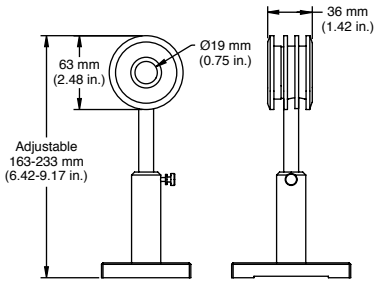
These sensors are designed for use with high-peak-power, low repetition rate, Q-switched Nd:YAG lasers. A volume-absorbing substrate mounted in front of the detector absorbs the bulk of the laser energy rather than all of the energy striking the front surface of the detector element. This results in a much higher damage threshold, approaching 2 J/cm², at relatively low repetition rates of approximately 10 pps. For damage thresholds approaching 5 J/cm² the PM30V1Q uses an additional quartz diffuser to help scatter the beam before it hits the absorber surface. A removable front aperture allows easy replacement of the volume-absorbing substrate should it be damaged (replacement absorbers may be ordered using part number 0011-8935, PMV1-KIT).

**Device Specifications**

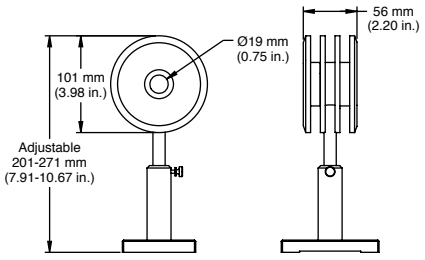
| Model | PM10V1 | PM30V1 | PM30V1Q |
|---|---|---|---|
| Wavelength Range (µm) | 0.25 to 3 | | 0.266 to 1.064[1] |
| Power Range | 10 mW to 10W | 100 mW to 30W | |
| Max. Intermittent Power (<5 min.)(W) | 15 | 50 | |
| Resolution (mW) | 1 | 10 | |
| Max. Power Density | 50 W/cm² | | |
| Max. Energy Density | 2 J/cm², 1064 nm, 10 ns | | 5 J/cm², 1064 nm, 10 ns |
| Response Time (sec.) | 3 | | |
| Detector Coating | Volume Absorbing | | |
| Active Area Diameter (mm) | 19 | | |
| Dimensions (mm) | Ø63 x 36 (2.4 x 1.4 in.) | Ø101 x 56 (3.9 x 2.2 in.) | |
| Calibration Uncertainty (%) | ±1 | | |
| Calibration Wavelength (nm) | 514 | | 514[1] |
| Cooling Method | Air-cooled | | |
| Cable Type | PM DB-25 | | |
| Cable Length (m) | 2 | | |
| Part Number | 1098338 | 1098429 | 1098414 |

[1] Diffuser transmission calibrated at 266 nm, 355 nm, 532 nm and 1064 nm.

**PM10V1**




**PM30V1/PM30V1Q**



# Thermopile Sensors with UV Coating

## 10 mW to 30W

Model PM2X, PM10X, PM30X

**Features**

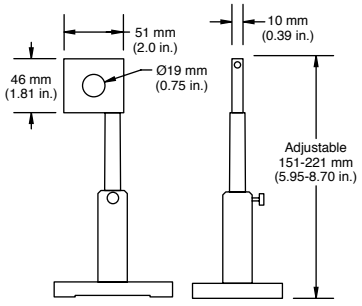
- **UV coating is optimized for DUV**
- **Spectral range: 0.15 µm to 1 µm**
- **1 mW to 10 mW resolution**
- **19 mm**

The following sensors are similar to models shown on previous pages, except they incorporate a UV coating that is optimized for use at ultraviolet wavelengths. Spectral compensation allows the sensors to be used from 157 nm to 1064 nm.

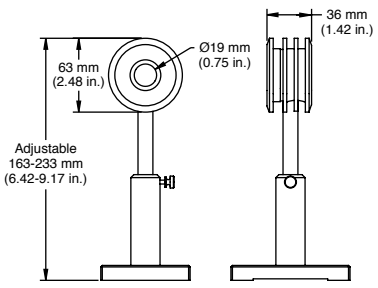
**Device Specifications**

| Model | PM2X | PM10X | PM30X |
|---|---|---|---|
| Wavelength Range (µm) | | 0.15 to 1 | |
| Power Range | 10 mW to 2W | 10 mW to 10W | 100 mW to 30W |
| Long-Pulse Joules Range (J) | 0.5 to 2 | 0.5 to 10 | 0.5 to 50 |
| Max. Intermittent Power (<5 min.) (W) | 3 | 30 | 50 |
| Resolution (mW) | 1 | 1 | 10 |
| Max. Power Density | | 26 kW/cm² | |
| Max. Energy Density | | 0.6 J/cm², 1064 nm, 10 ns | |
| Response Time (sec.) | | 2 | |
| Detector Coating | | UV | |
| Active Area Diameter (mm) | | 19 | |
| Dimensions (mm) | 46 x 51 x 10 (1.8 x 2.0 x 0.3 in.) | Ø63 x 36 (2.4 x 1.4 in.) | Ø101 x 56 (3.9 x 2.2 in.) |
| Calibration Uncertainty (%) | | ±1 | |
| Calibration Wavelength (nm) | | 514 | |
| Cooling Method | | Air-cooled | |
| Cable Type | | PM DB-25 | |
| Cable Length (m) | | 2 | |
| Part Number | 1098457 | 1098423 | 1098498 |

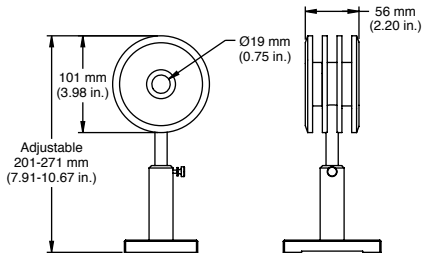
**PM2X**




**PM10x**




**PM30x**



# Thermopile Sensors with UV Coating

## 300 mW to 150W

Model PM150X, PM150-50XC

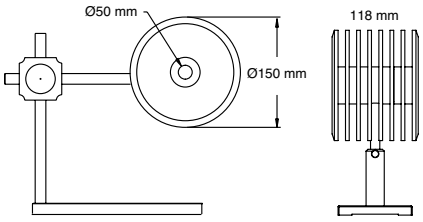
**Features**

- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 30 mW resolution
- 50 mm apertures

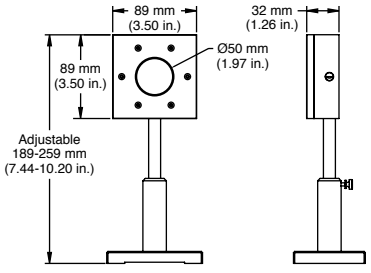
**Device Specifications**

| Model | PM150X | PM150-50XC |
|---|---|---|
| Wavelength Range (µm) | 0.15 to 1 | |
| Power Range | 300 mW to 150W | |
| Long-Pulse Joules Range (J) | 1 to 150 | |
| Max. Intermittent Power (<5 min.)(W) | 300 | 80 (air-cooled) |
| Resolution (mW) | 30 | |
| Max. Power Density | 26 kW/cm² | |
| Max. Energy Density | 0.6 J/cm2, 1064 nm, 10 ns | |
| Response Time (sec.) | 5 | |
| Detector Coating | UV | |
| Active Area Diameter (mm) | 50 | |
| Dimensions (mm) | 150 x 118 (5.9 x 4.6 in.) | 89 x 89 x 32 (3.5 x 3.5 x 1.2 in.) |
| Calibration Uncertainty (%) | ±1 | |
| Calibration Wavelength (nm) | 514 | |
| Cooling Method | Air-cooled | Water-cooled |
| Cable Type | PM DB-25 | |
| Cable Length (m) | 2 | |
| Part Number | 1098455 | 1098443 |

**PM150X**




**PM150-50XC**



# Thermopile Sensors with UV Coating

## 1W to 1 kW

Model PM200F-50X, PM300F-50X, PM1KX

**Features**

- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 100 mW to 1W resolution
- 50 mm apertures

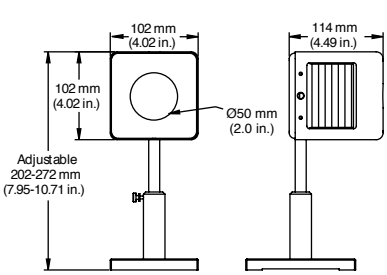


**Device Specifications**

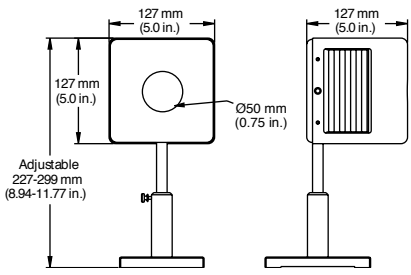
| Model | PM200F-50X | PM300F-50X | PM1KX |
|---|---|---|---|
| Wavelength Range (µm) | 0.15 to 1 | | 0.15 to 1 |
| Power Range (W) | 1 to 200 | 1 to 300 | 100 to 1000 |
| Long-Pulse Joules Range (J) | 1 to 200 | 1 to 300 | – |
| Max. Intermittent Power (<5 min.)(W) | 300 | 450 | 1500 |
| Resolution (mW) | 100 | 100 | 1000 |
| Max. Power Density | 26 kW/cm² | | 1 to 10 kW/cm² [1] |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | 0.6 J/cm², 1064 nm, 10 ns |
| Response Time (sec.) | 5 | | 30 |
| Detector Coating | UV | | UV |
| Active Area Diameter (mm) | 50 | | 50 |
| Dimensions (mm) | 102 x 102 x 114 (4.0 x 4.0 x 4.4 in.) | 127 x 127 x 127 (5 x 5 x 5 in.) | Ø120 x 59 (4.7 x 2.3 in.) |
| Calibration Uncertainty (%) | ±1 | | ±5 |
| Calibration Wavelength (nm) | 514 | | 1064 |
| Cooling Method | Fan-cooled | | Water-cooled |
| Cable Type | PM DB-25 | | PM DB-25 |
| Cable Length (m) | 2 | | 2 |
| Part Number | 1113493 | 1098481 | 1115484 |

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

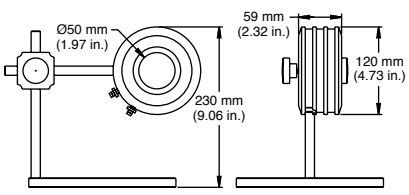
**PM200F-50X**




**PM300F-50X**




**PM1KX**



# Power Sensor Accessories



## Thermal SmartSensor Adapter

The Thermal SmartSensor Adapter converts LM-model position-sensing thermopiles and LM-2 optical sensors for use with FieldMaxII, FieldMate and EPM2000 meters.

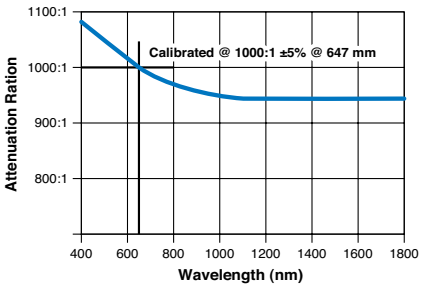
Designed for use with multiple sensors, this adapter can read the sensor EEPROM contents and program itself when powered up via the meter connection.

Note: Beam position information is not available when using these meters.

| Part Number | Description |
|---|---|
| 1056827 | Thermal SmartSensor Adapter |

## 1000:1 Attenuator

This attenuator is used with OP-2 VIS, LM-2 VIS, OP-2 IR and LM-2 IR sensors to allow operation up to 5W in the visible and 3W in the infrared regions. The attenuator threads into the sensor in place of the light shield to provide from 1100:1 to 950:1 attenuation. Each attenuator is calibrated for 1000:1 ±5% at 647 nm and is supplied with a calibration certificate. The useful spectral range is 400 to 1800 nm.




| Part Number | Description |
|---|---|
| 1098318 | 1000:1 Attenuator for OP-2 and LM-2 Sensors |

## Fiber-Optic Connector Adapters

The following fiber-optic adapters can be mounted directly onto the 3/4-32 threads on the front of LM-2, OP-2, LM-3, LM-10, and LM-150FS sensors. These fiber adapters can also be used with our 1.035-40M adapter ring to fit on the LM-20, LM-45, LM-100, LM-150 LS, and LM-200 sensors.

| Part Number | Description | Sensors |
|---|---|---|
| 1098589 | SMA-Type Connector | LM-2, OP-2, LM-3, LM-10, LM-150 FS |
| 1098339 | FC/PC-Type Connector | LM-2, OP-2, LM-3, LM-10, LM-150 FS |
| 33-9432-000 | 1.035-40M Adapter Ring | LM-20, LM-45, LM-100, LM-150 LS, LM-200 |

The following fiber adapters can be mounted onto the front of the PS10 sensor in place of the removable light tube.

| Part Number | Description | Sensors |
|---|---|---|
| 0012-3860 | PS-SMA-Type Connector | PS10 |
| 0012-3863 | PS-FC-Type Connector | PS10 |

# EnergyMax - Laser Energy Sensors

## Introduction and Selection Charts

**Features**

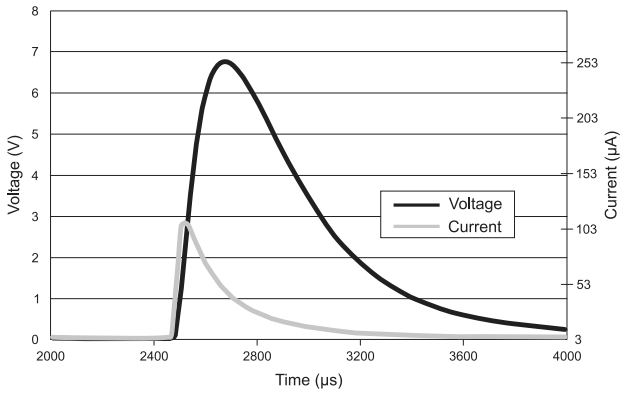
- **Superior damage resistance**
- **High repetition rate operation**
- **Large dynamic range gives each sensor broad coverage**
- **Low noise and excellent linearity for greater accuracy**
- **Large active area**

Coherent EnergyMax sensors enable laser pulse energy measurement over a broad range of wavelengths, repetition rates, pulse energies and beam diameters. With their unique combination of superior performance and user-friendly convenience, EnergyMax sensors are your best choice no matter what your particular laser energy measurement need. EnergyMax sensors are highly linear in terms of repetition rate, laser pulse width, and measured energy. They are also accurate across a broad range of wavelengths due to onboard wavelength compensation. In addition, automatic temperature compensation accounts for changes in ambient temperature, as well as for heat generated by absorption of the laser energy. Temperature compensation also enables the use of user-installable heat sinks for even higher average power handling capabilities. Coherent EnergyMax sensors are the most linear and accurate on the market.

## Fundamental Principles

Unlike all other thermal detectors, pyroelectrics measure the rate of change of the detector temperature, rather than the temperature value itself. As a result, the response speed of the pyroelectric is usually limited by its electrical circuit design and the thermal resistance of the absorptive coating. In contrast, other thermal detectors (such as thermopiles and bolometers) are limited by slower thermal response speeds, typically on the order of seconds. Pyroelectrics respond only to changing radiation that is chopped, pulsed, or otherwise modulated, so they ignore steady background radiation that is not changing with time. Their combination of wide uniform spectral response, sensitivity, and high speed makes pyroelectrics ideal choices for a vast number of electro-optic applications.

The EnergyMax sensor line uses a pyroelectric element to measure the energy in a laser pulse. It does this by producing a large electrical charge for a small change in temperature. The active sensor circuit takes the current from the sensor element and converts it to a voltage that the instrument can measure. The figure below shows the relationship between the current response of the pyroelectric element and the output voltage of the sensor circuit. The relationship between the current response and the output voltage response is fixed so that the calibrated peak voltage of the output is the integrated energy of the laser pulse.

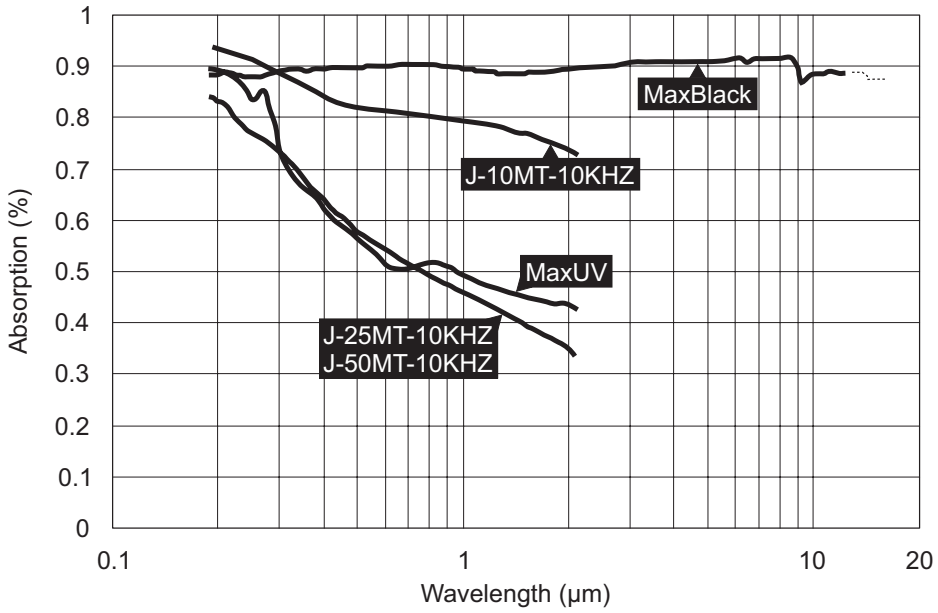


# EnergyMax - Laser Energy Sensors

## Introduction and Selection Charts



All EnergyMax sensors incorporate a diffuse coating to minimize specular reflections and eliminate spurious beams that can re-enter the laser cavity. In addition, all EnergyMax sensors include onboard electronics that contain built-in wavelength compensation factors. When using the sensor with a meter such as LabMax or FieldMaxII, enter the wavelength of the laser being measured into the meter and this will automatically compensate for the sensor output. The chart below plots the typical absorption percentage of each coating.



| Meter Compatibility Chart | | LabMax-TOP | FieldMaxII-TOP & -P | EPM2000 |
|---|---|---|---|---|
| | All J-10MB-, J-25MB-, J-50MB-, J-25MUV-, J-50MUV- EnergyMax Models | • | • | • |
| | J-10MT-10KHZ, J-25MT-10KHz, J-50MT-10KHZ EnergyMax Models | • | | • |

## Explanation of Part Numbers

EnergyMax part numbers are "Smart" part numbers that have the following meaning:

**J –** **Active Area Diameter** (10, 25, or 50 mm) – **Coating Type** (MT for Diffuse Metallic; MB for MaxBlack™; MUV for MaxUV™) – **Descriptive Suffix** (LE for Low Energy; HE for High Energy; 10 KHZ for Max. Rep. Rate; 193 and 248 Calibrated Wavelength)

**J:** Represents an energy sensor

**Example: J-10MB-LE** is an energy sensor with a 10 mm active area diameter MaxBlack coating for low energy measurements

# EnergyMax - Laser Energy Sensors

## Introduction and Selection Charts

The next table summarizes the maximum average power rating for each sensor. These power levels are achieved by combining active temperature compensation circuitry and enhanced thermal management techniques. Maximum average power is wavelength dependent because absorption changes with wavelength. Reference the spectral absorption chart on the previous page for use at wavelengths other than those listed in the table below. Maximum average power is inversely proportional to the spectral absorption.

The 25 mm and 50 mm aperture sensors can accept optional heat sinks that users can install by mounting them on the back of the sensor. The heat sinks expand the average power handling capability as outlined below. See the Accessories section on page 48 for more information about heat sinks.

**EnergyMax Average Power Capabilities**

| Model | Wavelength[4] (nm) | Heat Sink | | | |
|---|---|---|---|---|---|
| | | None | Small | Medium | Large |
| J-50MB-HE[1] | 1064 | 10W | – | – | 24W |
| J-50MB-LE[1] | 1064 | 10W | – | – | 24W |
| J-25MB-HE[2] | 1064 | 5W | 10W | 15W | – |
| J-25MB-LE[2] | 1064 | 5W | 10W | 15W | – |
| J-10MB-HE[3] | 1064 | 4W | – | – | – |
| J-10MB-LE[3] | 1064 | 4W | – | – | – |
| J-50MT-10KHZ[1] | 1064 | 20W | – | – | 49W |
| J-25MT-10KHZ[2] | 1064 | 10W | 20W | 31W | – |
| J-10MT-10KHZ[3] | 1064 | 1W | – | – | – |
| J-50MB-YAG[1] | 1064 | 20W | – | – | 48W |
| J-25MB-IR[2] | 1064 | 20W | 41W | 62W | – |
| J-50MUV-248[1] w/o Diffuser | 248 | 10W | – | – | 25W |
| J-50MUV-248[1] w/Diffuser | 248 | 15W | – | – | 36W |
| J-50MUV-193[1] w/o Diffuser | 193 | 10W | – | – | 30W |
| J-50MUV-193[1] w/Diffuser | 193 | 18W | – | – | 43W |
| J-25MUV-248[2] | 248 | 5W | 10W | 16W | – |
| J-25MUV-193[2] | 193 | 5W | 10W | 15W | – |

[1] 50 mm EnergyMax sensors are compatible with the large heat sink.
[2] 25 mm EnergyMax sensors are compatible with small and medium heat sinks.
[3] 10 mm EnergyMax sensors do not have a heat sink available.
[4] Average power ratings are based upon testing at the listed wavelength.

Use the following chart to identify sensors that operate within the energy range you intend to measure. Selection charts on the following pages of this guide will help you select more exactly the best sensor for your application.

**EnergyMax Energy Range Capabilities**

| Model | Energy Range | Wide Dynamic Range for All EnergyMax Sensor Categories: 100 nJ · 1 µJ · 10 µJ · 100 µJ · 1 mJ · 10 mJ · 100 mJ · 1J · 10J |
|---|---|---|
| J-50MB-HE | 1 mJ to 2J | |
| J-50MB-LE | 250 µJ to 500 mJ | |
| J-25MB-HE | 500 µJ to 1J | |
| J-25MB-LE | 25 µJ to 50 mJ | |
| J-10MB-HE | 10 µJ to 20 mJ | |
| J-10MB-LE | 300 nJ to 600 µJ | |
| J-50MT-10KHZ | 500 µJ to 1J | |
| J-25MT-10KHZ | 50 µJ to 100 mJ | |
| J-10MT-10KHZ | 100 nJ to 200 µJ | |
| J-50MB-YAG | 1.5 mJ to 3J | |
| J-25MB-IR | 1.5 mJ to 3J | |
| J-50MUV-248 w/o Diffuser | 500 µJ to 1J | |
| J-50MUV-248 w/Diffuser | 500 µJ to 1J | |
| J-50MUV-193 w/o Diffuser | 125 µJ to 250 mJ | |
| J-50MUV-193 w/Diffuser | 125 µJ to 250 mJ | |
| J-25MUV-248 | 125 µJ to 250 mJ | |
| J-25MUV-193 | 50 µJ to 100 mJ | |

# EnergyMax - Laser Energy Sensors

## Introduction and Selection Charts

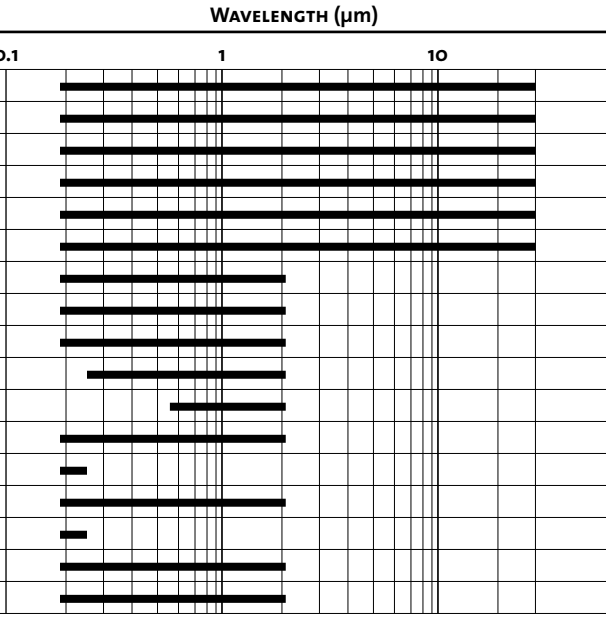


The next selection chart shows the range of wavelengths that can be measured with each sensor. This characteristic is coating dependent, so sensors with diffusers may have a narrower spectral range than similar sensors without diffusers.

The spectral compensation of each sensor is unique to that serial number, and is based upon spectral scans performed on each sensor disk (and on each optic if the sensor has a diffuser). The spectral compensation provides greater measurement accuracy for wavelengths that differ from the optical calibration wavelength.

**EnergyMax Wavelength Capabilities**

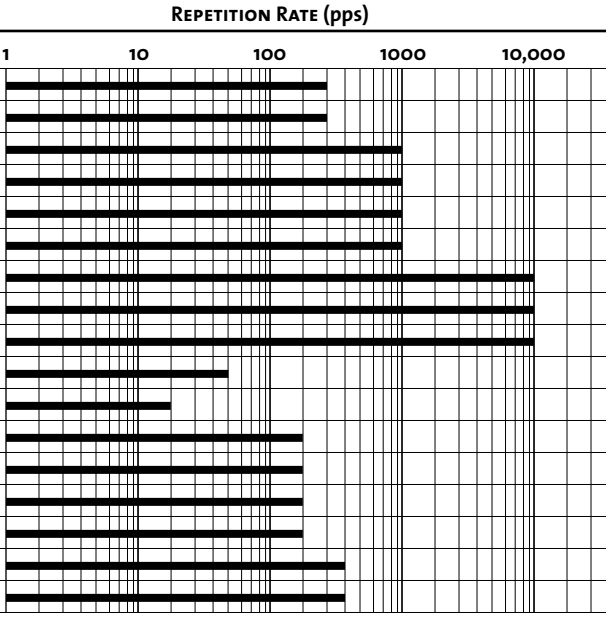
| Model | Wavelength (µm) |
|---|---|
| J-50MB-HE | 0.19 to 12.0 |
| J-50MB-LE | 0.19 to 12.0 |
| J-25MB-HE | 0.19 to 12.0 |
| J-25MB-LE | 0.19 to 12.0 |
| J-10MB-HE | 0.19 to 12.0 |
| J-10MB-LE | 0.19 to 12.0 |
| J-50MT-10KHZ | 0.19 to 2.1 |
| J-25MT-10KHZ | 0.19 to 2.1 |
| J-10MT-10KHZ | 0.19 to 2.1 |
| J-50MB-YAG | 0.266 to 2.1 |
| J-25MB-IR | 0.532 to 2.1 |
| J-50MUV-248 w/o Diffuser | 0.19 to 2.1 |
| J-50MUV-248 w/Diffuser | 0.19 to 0.266 |
| J-50MUV-193 w/o Diffuser | 0.19 to 2.1 |
| J-50MUV-193 w/Diffuser | 0.19 to 0.266 |
| J-25MUV-248 w/o Diffuser | 0.19 to 2.1 |
| J-25MUV-193 w/o Diffuser | 0.19 to 2.1 |




EnergyMax sensors are based upon pyroelectric technology and can therefore measure lasers at high repetition rates. The maximum repetition rate is primarily dependent upon the thermal resistance of the coating and the maximum pulse width the sensor is designed to measure. Refer to the summary table on page 43 for maximum laser pulse width limitations.

**EnergyMax Repetition Rate Capabilities**

| Model | Rep. Rate (pps) |
|---|---|
| J-50MB-HE | up to 300 |
| J-50MB-LE | up to 300 |
| J-25MB-HE | up to 1000 |
| J-25MB-LE | up to 1000 |
| J-10MB-HE | up to 1000 |
| J-10MB-LE | up to 1000 |
| J-50MT-10KHZ | up to 10,000 |
| J-25MT-10KHZ | up to 10,000 |
| J-10MT-10KHZ | up to 10,000 |
| J-50MB-YAG | up to 50 |
| J-25MB-IR | up to 20 |
| J-50MUV-248 w/o Diffuser | up to 200 |
| J-50MUV-248 w/Diffuser | up to 200 |
| J-50MUV-193 w/o Diffuser | up to 200 |
| J-50MUV-193 w/Diffuser | up to 200 |
| J-25MUV-248 | up to 400 |
| J-25MUV-193 | up to 400 |



# EnergyMax - Laser Energy Sensors

## Energy Sensor Summary Specifications

Before using a sensor, it is important to ensure that the laser beam will not damage the sensor coating. The damage threshold is also wavelength dependent, and maximum energy density thresholds are listed for common laser wavelengths in the table below. At other wavelengths it is safe to interpolate between the listed values.

**EnergyMax Damage Threshold Capabilities**

| | Damage Threshold (mJ/cm²) | | | | | |
|---|---|---|---|---|---|---|
| **Model** | **193 nm** | **248 nm** | **266 nm** | **355 nm** | **532 nm** | **1064 nm** |
| J-50MB-HE | 40 | 170 | 170 | 140 | 250 | 500 |
| J-50MB-LE | 40 | 170 | 170 | 140 | 250 | 500 |
| J-25MB-HE | 40 | 170 | 170 | 140 | 250 | 500 |
| J-25MB-LE | 40 | 170 | 170 | 140 | 250 | 500 |
| J-10MB-HE | 40 | 170 | 170 | 140 | 250 | 500 |
| J-10MB-LE | 40 | 170 | 170 | 140 | 250 | 500 |
| J-50MT-10KHZ | 150 | 200 | 200 | 390 | 500 | 500 |
| J-25MT-10KHZ | 150 | 200 | 200 | 390 | 500 | 500 |
| J-10MT-10KHZ | 40 | 40 | 40 | 50 | 50 | 50 |
| J-50MB-YAG | – | – | 1000 | 750 | 2800 | 14,000 |
| J-25MB-IR | – | – | – | – | 1500 | 5000 |
| J-50MUV-248 w/o Diffuser | 200 | 260 | 260 | 300 | 375 | 375 |
| J-50MUV-248 w/Diffuser | 400 | 520 | 520 | – | – | – |
| J-50MUV-193 w/o Diffuser | 200 | 260 | 260 | 300 | 375 | 375 |
| J-50MUV-193 w/Diffuser | 400 | 520 | 520 | – | – | – |
| J-25MUV-248 | 200 | 260 | 260 | 300 | 375 | 375 |
| J-25MUV-193 | 200 | 260 | 260 | 300 | 375 | 375 |

The table below shows the key specifications for each sensor. Additional specifications can be found on pages 44 to 48.

| | | | | | Max. Average Power | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Part Number** | **Description** | **Wavelength Range (µm)** | **Min. Energy** | **Max. Energy** | **No H.S.[1]** | **Small H.S.** | **Med. H.S.** | **Large H.S.** | **Max. Rep. Rate (pps)** | **Max. Pulse Width (µs)** | **Active Area Dia. (mm)** | **Detector Coating** | **Diffuser** | **Calibration Wavelength** |
| 1110573 | J-50MB-HE | 0.19 to 12 | 1 mJ | 2J | 10 | – | – | 24 | 300 | 57 | 50 | MaxBlack | None | 1064 |
| 1110576 | J-50MB-LE | 0.19 to 12 | 250 µJ | 500 mJ | 10 | – | – | 24 | 300 | 57 | 50 | MaxBlack | None | 1064 |
| 1110746 | J-25MB-HE | 0.19 to 12 | 500 µJ | 1J | 5 | 10 | 15 | – | 1000 | 17 | 25 | MaxBlack | None | 1064 |
| 1110743 | J-25MB-LE | 0.19 to 12 | 25 µJ | 50 mJ | 5 | 10 | 15 | – | 1000 | 17 | 25 | MaxBlack | None | 1064 |
| 1110843 | J-10MB-HE | 0.19 to 12 | 10 µJ | 20 mJ | 4 | – | – | – | 1000 | 17 | 10 | MaxBlack | None | 1064 |
| 1110855 | J-10MB-LE | 0.19 to 12 | 300 nJ | 600 µJ | 4 | – | – | – | 1000 | 17 | 10 | MaxBlack | None | 1064 |
| 1110574 | J-50MT-10KHZ | 0.19 to 2.1 | 500 µJ | 1J | 20 | – | – | 49 | 10000 | 1.7 | 50 | Diff. Met.[2] | None | 1064 |
| 1110747 | J-25MT-10KHZ | 0.19 to 2.1 | 50 µJ | 100 mJ | 10 | 20 | 31 | – | 10000 | 1.7 | 25 | Diff. Met. | None | 1064 |
| 1110856 | J-10MT-10KHZ | 0.19 to 2.1 | 100 nJ | 200 µJ | 1 | – | – | – | 10000 | 1.7 | 10 | Diff. Met. | None | 1064 |
| 1110744 | J-50MB-YAG | 0.266 to 2.1 | 1.5 mJ | 3J | 20 | – | – | 48 | 50 | 340 | 50 | MaxBlack | YAG | 1064 |
| 1110577 | J-25MB-IR | 0.532 to 2.1 | 1.5 mJ | 3J | 20 | 41 | 62 | – | 20 | 860 | 25 | MaxBlack | IR | 1064 |
| 1146243 | J-50MUV-248 w/o Diffuser | 0.19 to 2.1 | 500 µJ | 1J | 10 | – | – | 25 | 200 | 86 | 50 | MaxUV | None | 248 |
| 1110572 | J-50MUV-248 w/Diffuser | 0.19 to 0.266 | 500 µJ | 1J | 15 | – | – | 36 | 200 | 86 | 50 | MaxUV | DUV | 248 |
| 1146237 | J-50MUV-193 w/o Diffuser | 0.19 to 2.1 | 125 µJ | 250 mJ | 10 | – | – | 30 | 200 | 86 | 50 | MaxUV | None | 193 |
| 1110575 | J-50MUV-193 w/Diffuser | 0.19 to 0.266 | 125 µJ | 250 mJ | 18 | – | – | 43 | 200 | 86 | 50 | MaxUV | DUV | 193 |
| 1110745 | J-25MUV-248 | 0.19 to 2.1 | 125 µJ | 250 mJ | 5 | 10 | 16 | – | 400 | 43 | 25 | MaxUV | None | 248 |
| 1110741 | J-25MUV-193 | 0.19 to 2.1 | 50 µJ | 100 mJ | 5 | 10 | 15 | – | 400 | 43 | 25 | MaxUV | None | 193 |

[1] Heat Sink.
[2] Diffuse metallic.

# EnergyMax Sensors

## MaxBlack Coating

### Features

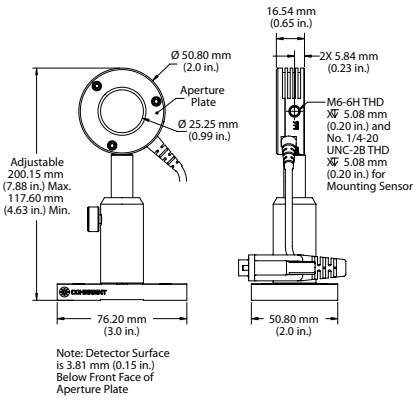
- Unique MaxBlack coating increases damage threshold, allows high repetition rate operation, and improves mechanical durability
- Operate over the 190 nm to 12 µm range
- Enable pulse energy measurements from 300 nJ to 2J with high signal-to-noise characteristics
- Measure single shot to 1 kHz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

These sensors allow measurements over a wide range of wavelengths, beam diameters, average power levels, and repetition rates. The MaxBlack coating on these sensors provides significant damage resistance and mechanical durability characteristics compared to the black paint coatings often used on broadband sensors in the past.

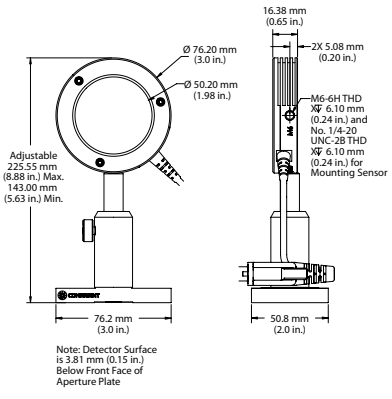
**Device Specifications**

| Model | J-50MB-HE | J-50MB-LE | J-25MB-HE | J-25MB-LE | J-10MB-HE | J-10MB-LE |
|---|---|---|---|---|---|---|
| Energy Range | 1 mJ to 2J | 250 µJ to 500 mJ | 500 µJ to 1J | 25 µJ to 50 mJ | 10 µJ to 20 mJ | 300 nJ to 600 µJ |
| Noise Equivalent Energy | <33 µJ | <8 µJ | <16 µJ | <1 µJ | <0.5 µJ | <20 nJ |
| Wavelength Range (µm) | 0.19 to 12 | | | | | |
| Active Area Diameter (mm) | 50 | 50 | 25 | 25 | 10 | 10 |
| Maximum Average Power (W) | 10 | 10 | 5 | 5 | 4 | 4 |
| Maximum Pulse Width (µs) | 57 | | 17 | | | |
| Maximum Repetition Rate (pps) | 300 | 300 | 1000 | 1000 | 1000 | 1000 |
| Maximum Energy Density (mJ/cm²) | 500 (at 1064 nm, 10 ns) | | | | | |
| Detector Coating | MaxBlack | | | | | |
| Diffuser | No | | | | | |
| Calibration Wavelength (nm) | 1064 | | | | | |
| Calibration Uncertainty (%) | ±2 | | | | | |
| Energy Linearity (%) | ±3 | | | | | |
| Cable Length (m) | 2.5 | | | | | |
| Cable Type | J DB-25 | | | | | |
| Part Number | 1110573 | 1110576 | 1110746 | 1110743 | 1110843 | 1110855 |

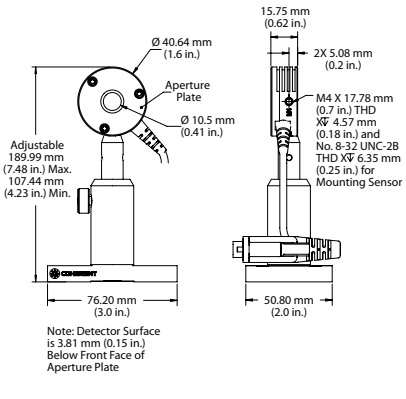
**J-25MB-HE and -LE**


16.54 mm (0.65 in.)
Ø 50.80 mm (2.0 in.)
2X 5.84 mm (0.23 in.)
Aperture Plate
Ø 25.25 mm (0.99 in.)
M6-6H THD ↧ 5.08 mm (0.20 in.) and No. 1/4-20 UNC-2B THD ↧ 5.08 mm (0.20 in.) for Mounting Sensor
Adjustable 200.15 mm (7.88 in.) Max. 117.60 mm (4.63 in.) Min.
76.20 mm (3.0 in.)
50.80 mm (2.0 in.)
Note: Detector Surface is 3.81 mm (0.15 in.) Below Front Face of Aperture Plate

**J-50MB-HE and -LE**


16.38 mm (0.65 in.)
Ø 76.20 mm (3.0 in.)
2X 5.08 mm (0.20 in.)
Ø 50.20 mm (1.98 in.)
M6-6H THD ↧ 6.10 mm (0.24 in.) and No. 1/4-20 UNC-2B THD ↧ 6.10 mm (0.24 in.) for Mounting Sensor
Adjustable 225.55 mm (8.88 in.) Max. 143.00 mm (5.63 in.) Min.
76.2 mm (3.0 in.)
50.8 mm (2.0 in.)
Note: Detector Surface is 3.81 mm (0.15 in.) Below Front Face of Aperture Plate

**J-10MB-HE and -LE**


15.75 mm (0.62 in.)
Ø 40.64 mm (1.6 in.)
2X 5.08 mm (0.2 in.)
Aperture Plate
Ø 10.5 mm (0.41 in.)
M4 X 17.78 mm (0.7 in.) THD ↧ 4.57 mm (0.18 in.) and No. 8-32 UNC-2B THD ↧ 6.35 mm (0.25 in.) for Mounting Sensor
Adjustable 189.99 mm (7.48 in.) Max. 107.44 mm (4.23 in.) Min.
76.20 mm (3.0 in.)
50.80 mm (2.0 in.)
Note: Detector Surface is 3.81 mm (0.15 in.) Below Front Face of Aperture Plate

# EnergyMax Sensors

## Diffuse Metallic Coating

### Features

- Unique diffuse metallic coating delivers increased damage threshold, allows high repetition rate operation and reduces specular reflectance
- Operate over the entire 190 nm to 2.1 µm range
- Enable pulse energy measurements from 100 nJ to 1J with high signal-to-noise characteristics
- Measure up to 10 kHz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation*

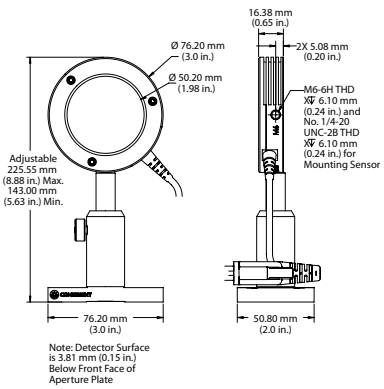
These sensors use a diffuse metallic coating that enables measurements at high and low repetition rates across a wide range of energies, wavelengths and beam sizes. The damage resistance at 532 nm and shorter wavelengths is even greater than the MaxBlack coating. These are great all-purpose sensors for the 190 nm to 2.1 µm region and offer the lowest energy range of our EnergyMax line.

**Device Specifications**

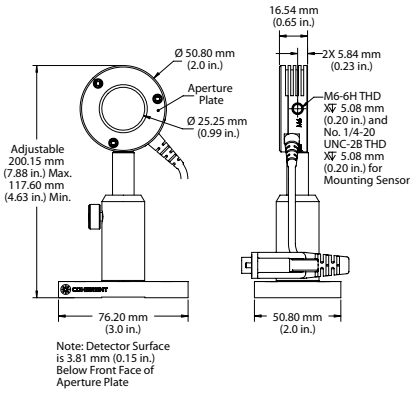
| Model | J-50MT-10KHZ | J-25MT-10KHZ | J-10MT-10KHZ |
|---|---|---|---|
| Energy Range | 500 µJ to 1J | 50 µJ to 100 mJ | 100 nJ to 200 µJ |
| Noise Equivalent Energy | <16 µJ | <2 µJ | <10 nJ |
| Wavelength Range (µm) | | 0.19 to 2.1 | |
| Active Area Diameter (mm) | 50 | 25 | 10 |
| Maximum Average Power (W) | 20 | 10 | 1 |
| Maximum Pulse Width (µs) | | 1.7 | |
| Maximum Repetition Rate (pps) | | 10,000 | |
| Maximum Energy Density (mJ/cm²) | 500 (at 1064 nm, 10 ns) | | 50 (at 1064 nm, 10 ns) |
| Detector Coating | | Diffuse Metallic | |
| Diffuser | | No | |
| Calibration Wavelength (nm) | | 1064 | |
| Calibration Uncertainty (%) | | ±2 | |
| Energy Linearity (%) | | ±3 | |
| Cable Length (m) | | 2.5 | |
| Cable Type | | J DB-25 | |
| Part Number | 1110574 | 1110747 | 1110856 |

* Except J-10MT-10KHZ.

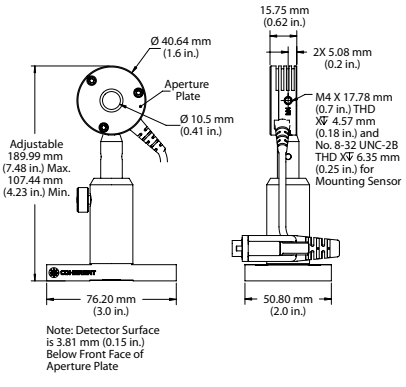
**J-50MT-10KHZ**


16.38 mm (0.65 in.)
Ø 76.20 mm (3.0 in.)
2X 5.08 mm (0.20 in.)
Ø 50.20 mm (1.98 in.)
M6-6H THD ↧ 6.10 mm (0.24 in.) and No. 1/4-20 UNC-2B THD ↧ 6.10 mm (0.24 in.) for Mounting Sensor
Adjustable 225.55 mm (8.88 in.) Max. 143.00 mm (5.63 in.) Min.
76.20 mm (3.0 in.)
50.80 mm (2.0 in.)
Note: Detector Surface is 3.81 mm (0.15 in.) Below Front Face of Aperture Plate

**J-25MT-10KHZ**


16.54 mm (0.65 in.)
Ø 50.80 mm (2.0 in.)
2X 5.84 mm (0.23 in.)
Aperture Plate
Ø 25.25 mm (0.99 in.)
M6-6H THD ↧ 5.08 mm (0.20 in.) and No. 1/4-20 UNC-2B THD ↧ 5.08 mm (0.20 in.) for Mounting Sensor
Adjustable 200.15 mm (7.88 in.) Max. 117.60 mm (4.63 in.) Min.
76.20 mm (3.0 in.)
50.80 mm (2.0 in.)
Note: Detector Surface is 3.81 mm (0.15 in.) Below Front Face of Aperture Plate

**J-10MT-10KHZ**


15.75 mm (0.62 in.)
Ø 40.64 mm (1.6 in.)
2X 5.08 mm (0.2 in.)
Aperture Plate
Ø 10.5 mm (0.41 in.)
M4 X 17.78 mm (0.7 in.) THD ↧ 4.57 mm (0.18 in.) and No. 8-32 UNC-2B THD ↧ 6.35 mm (0.25 in.) for Mounting Sensor
Adjustable 189.99 mm (7.48 in.) Max. 107.44 mm (4.23 in.) Min.
76.20 mm (3.0 in.)
50.80 mm (2.0 in.)
Note: Detector Surface is 3.81 mm (0.15 in.) Below Front Face of Aperture Plate

# EnergyMax Sensors

## MaxBlack Coating and Diffusers

### Features

- **Very high energy and peak power handling capabilities**
- **Operate at Nd: YAG fundamental and harmonics, and throughout the IR**
- **Enable pulse energy measurements from 1.5 mJ to 3J[1]**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation**
- **No need to either change diffusers during use or perform your own spectral calibrations**

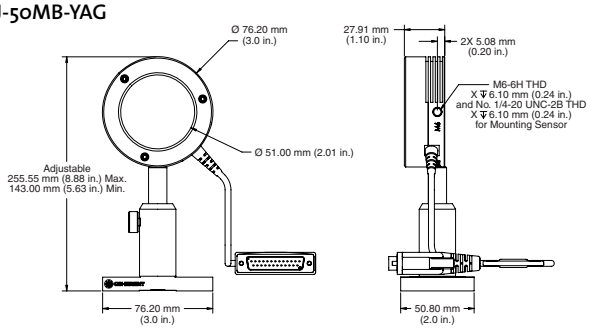
These sensors are specifically designed for high energy and high peak power lasers operating at relatively low repetition rates, such as those based on Nd:YAG, Ruby and Ho:YAG. The J-50MB-YAG sensor can be used with beams up to 35 mm in diameter and can work at 1064 nm, 532 nm, 355 nm and 266 nm without the need to change or self-calibrate diffusers or any other accessories. Both sensors combine a MaxBlack coating and a diffuser to produce superior damage resistance characteristics. This combination enables operation with lasers that produce either very high energy per pulse or very high peak fluences.

**Device Specifications**

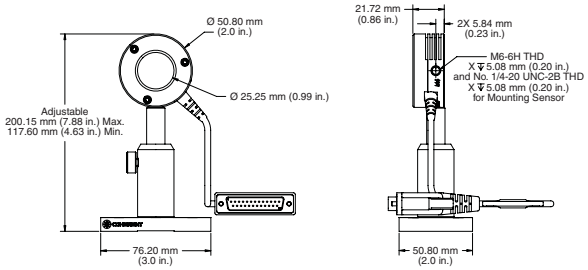
| Model | J-50MB-YAG | J-25MB-IR |
|---|---|---|
| Energy Range | 1.5 mJ to 3J[1] | 1.5 mJ to 3J |
| Noise Equivalent Energy (µJ) | <50 | <50 |
| Wavelength Range (µm) | 0.266 to 2.1 | 0.532 to 2.1 |
| Maximum Beam Size (mm) | 35 | 12.5 |
| Maximum Average Power (W) | 20 | 20 |
| Maximum Pulse Width (µs) | 340 | 860 |
| Maximum Repetition Rate (pps) | 50 | 20 |
| Maximum Energy Density (J/cm²) | 14.0 (at 1064 nm, 10 ns)<br>2.8 (at 532 nm, 10 ns)<br>0.75 (at 355 nm, 10 ns)<br>1.0 (at 266 nm, 10 ns) | 5.0 (at 1064 nm, 10 ns) |
| Detector Coating | MaxBlack | MaxBlack |
| Diffuser | YAG | IR |
| Calibration Wavelength (nm) | 1064 | 1064 |
| Calibration Uncertainty (%) | ±2 | ±3 |
| Energy Linearity (%) | ±3 | ±3 |
| Cable Length (m) | 2.5 | 2.5 |
| Cable Type | J DB-25 | J DB-25 |
| Part Number | 1110744 | 1110577 |

[1] Modifed sensors with higher repetition rate, energy range and/or pulse width are available. Contact factory.

**J-50MB-YAG**


Ø 76.20 mm (3.0 in.)
27.91 mm (1.10 in.)
2X 5.08 mm (0.20 in.)
M6-6H THD X ↧6.10 mm (0.24 in.) and No. 1/4-20 UNC-2B THD X ↧6.10 mm (0.24 in.) for Mounting Sensor
Ø 51.00 mm (2.01 in.)
Adjustable 255.55 mm (8.88 in.) Max. 143.00 mm (5.63 in.) Min.
76.20 mm (3.0 in.)
50.80 mm (2.0 in.)

**J-25MB-IR**


Ø 50.80 mm (2.0 in.)
Ø 25.25 mm (0.99 in.)
Adjustable 200.15 mm (7.88 in.) Max. 117.60 mm (4.63 in.) Min.
76.20 mm (3.0 in.)
21.72 mm (0.86 in.)
2X 5.84 mm (0.23 in.)
M6-6H THD X ↧5.08 mm (0.20 in.) and No. 1/4-20 UNC-2B THD X ↧5.08 mm (0.20 in.) for Mounting Sensor
50.80 mm (2.0 in.)

# EnergyMax Sensors

## MaxUV Coating

### Features

- Unique MaxUV coating delivers highest DUV damage threshold and long-term UV exposure resistance
- Operate over the 190 nm to 2.1 µm range
- Enable pulse energy measurements from 50 µJ to 1J
- Measure up to 400 Hz repetition rate
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation

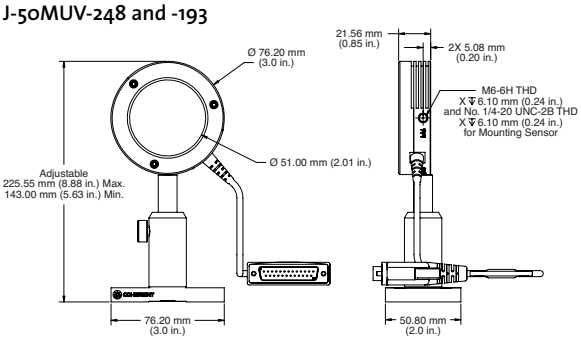
MaxUV-coated EnergyMax sensors are specifically optimized for use with ArF lasers operating at 193 nm and KrF lasers at 248 nm. These sensors feature high accuracy and large active areas (up to 50 mm), and use a unique coating called MaxUV that delivers superior long-term damage resistance.

Two of the 50 mm diameter models incorporate a DUV quartz diffuser for increased resistance to coating damage.

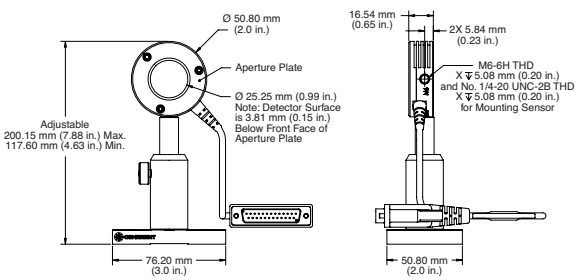
**Device Specifications**

| Model | J-50MUV-248 w/o Diffuser | J-50MUV-248 w/Diffuser | J-50MUV-193 w/o Diffuser | J-50MUV-193 w/Diffuser | J-25MUV-248 w/o Diffuser | J-25MUV-193 w/o Diffuser |
|---|---|---|---|---|---|---|
| Energy Range | 500 µJ to 1J | 500 µJ to 1J | 125 µJ to 250 mJ | 125 µJ to 250 mJ | 125 µJ to 250 mJ | 50 µJ to 100 mJ |
| Noise Equivalent Energy (µJ) | <16 | <16 | <4 | <4 | <4 | <2 |
| Wavelength Range (µm) | 0.19 to 2.1 | 0.19 to 0.266 | 0.19 to 2.1 | 0.19 to 0.266 | 0.19 to 2.1 | 0.19 to 2.1 |
| Active Area Diameter (mm) | 50 | 50 | 50 | 50 | 25 | 25 |
| Max. Average Power (W) | 10 | 15 | 10 | 18 | 5 | 5 |
| Max. Pulse Width (µs) | 86 | 86 | 86 | 86 | 43 | 43 |
| Max. Rep. Rate (pps) | 200 | 200 | 200 | 200 | 400 | 400 |
| Max. Energy Density ($mJ/cm^2$) | 260 (at 248 nm, 10 ns) | 520 (at 248 nm, 10 ns) | 200 (at 193 nm, 10 ns) | 400 (at 193 nm, 10 ns) | 260 (at 248 nm, 10 ns) | 200 (at 193 nm, 10 ns) |
| Detector Coating | MaxUV | | | | | |
| Diffuser | No | DUV | No | DUV | No | No |
| Calibration Wavelength (nm) | 248 | 248 | 193 | 193 | 248 | 193 |
| Calibration Uncertainty (%) | ±3 | | | | | |
| Energy Linearity (%) | ±3 | | | | | |
| Cable Length (m) | 2.5 | | | | | |
| Cable Type | J DB-25 | | | | | |
| Part Number | 1146243 | 1110572 | 1146237 | 1110575 | 1110745 | 1110741 |

**J-50MUV-248 and -193**


Ø 76.20 mm (3.0 in.)
Ø 51.00 mm (2.01 in.)
Adjustable
225.55 mm (8.88 in.) Max.
143.00 mm (5.63 in.) Min.
76.20 mm (3.0 in.)
21.56 mm (0.85 in.)
2X 5.08 mm (0.20 in.)
M6-6H THD
↧6.10 mm (0.24 in.)
and No. 1/4-20 UNC-2B THD
↧6.10 mm (0.24 in.)
for Mounting Sensor
50.80 mm (2.0 in.)

**J-25MUV-248 and -193**



# EnergyMax Accessories

## Heat Sinks

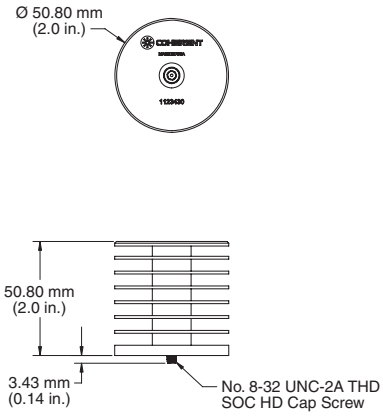
**Features**

- Extend EnergyMax average power
- Easily attach to EnergyMax sensors in the field
- Two heat sinks for 25 mm sensors (small and medium)
- One heat sink for 50 mm sensors (large)

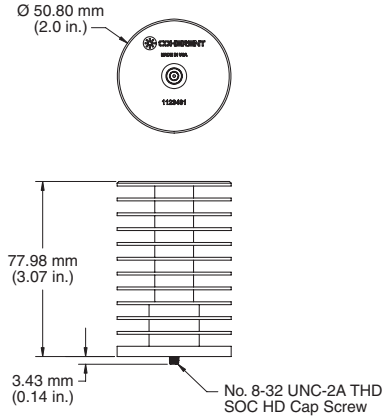
These heat sink accessories can be used to extend the energy and repetition rates of EnergyMax sensors by increasing the average power capability. Easily installed, they are simply theaded onto the back of a sensor housing with a cap screw retained within the heat sink.

The small and medium models, for use with sensors that have a 25 mm diameter aperture, increase the average power handling into the 10W to 30W range (coating and wavelength dependent). The large heat sink, for use with 50 mm diameter aperture sensors, increases the average power handling into the 20W to 40W range (coating and wavelength dependent). See Average Power Capability table on page 41 for sensor specifications.

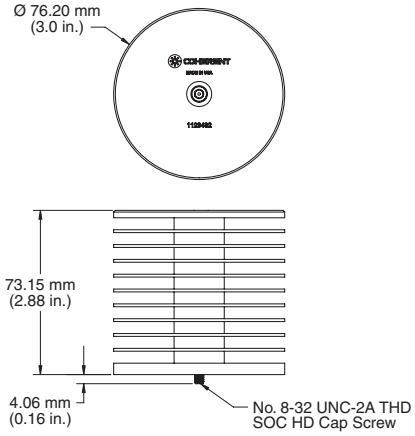
**Small Heat Sink**




**Medium Heat Sink**



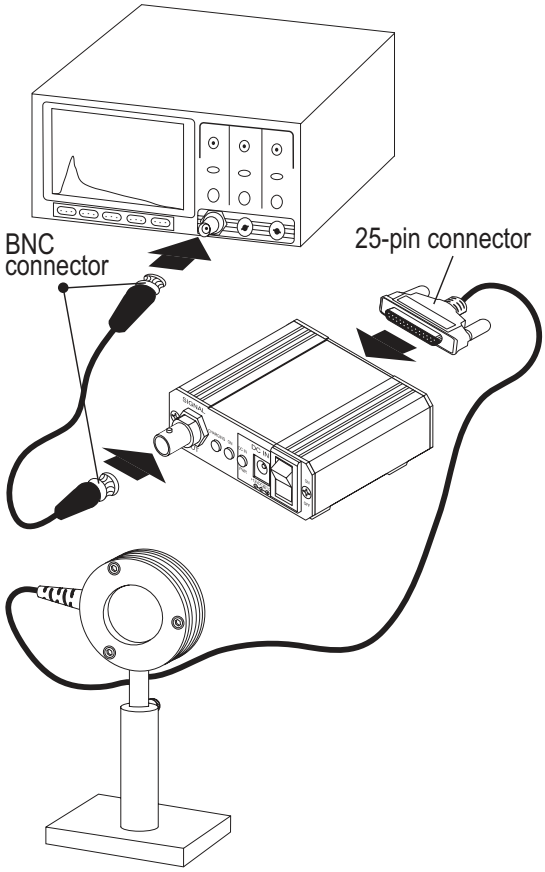

**Large Heat Sink**




| Part Number | Description |
|---|---|
| 1123430 | Small Heat Sink |
| 1123431 | Medium Heat Sink |
| 1123432 | Large Heat Sink |

# EnergyMax Accessories

## J-Power Energy Sensor DB-25-to-BNC Adapter




The J-Power is a compact sensor adapter that powers the EnergyMax active sensor circuit and passes the raw output voltage of the sensor directly to the BNC connector. The peak voltage of the output (as referenced from baseline voltage) can then be measured using an oscilloscope or other analog-to-digital input device. The calibrated peak voltage represents the integrated energy of the laser pulse.

| Part Number | Description |
|---|---|
| 1132205 | J-Power Energy Sensor Adapter |

## Pyroelectric Sensor Test Slides

For protection of your sensor when measuring unknown beams, the test slide is inserted into the beam and then examined for damage. These test slides are coated with the same absorbing coating as the pyroelectric sensors. If coating damage is visible, then attenuation is required before measuring the beam.

| Part Number | Description |
|---|---|
| 0011-4311 | Pyroelectric Test Slide – Black Coating (used with legacy sensors) |
| 1129175 | Pyroelectric Test Slide – Diffuse Metallic Coating |
| 0011-4313 | Pyroelectric Test Slide – MUV Coating |
| 0011-4314 | Pyroelectric Test Slide – MB Coating |

# EnergyMax - Laser Energy Sensors

## Measuring Energy with an Oscilloscope



To measure the energy of very high repetition rate and/or low-energy lasers, an oscilloscope can be used to monitor the output of an EnergyMax sensor.

This page presents a step-by-step procedure for setting up an oscilloscope and using a pyroelectric EnergyMax sensor to accurately read a peak voltage output.

1. To assure the accuracy of a pulse energy measurement, make sure the oscilloscope is calibrated properly. Also check the date for when the oscilloscope is due for recalibration.

2. Select a scope that has a sensitivity of at least 2 mV and a bandwidth of at least 20 MHz.

3. To connect an EnergyMax sensor to an oscilloscope you will need a J-POWER DB25-to-BNC accessory (available from Coherent).

4. Use the 1 Mohm input impedance of the oscilloscope when connecting any EnergyMax sensor.

5. Set up the scope as follows:
   - Bandwidth to 20 MHz
   - DC coupling
   - Trigger on "+" slope and "internal" source, or use the laser sync output and "external" source

6. Estimate the approximate EnergyMax sensor voltage output expected, based on the Rv (V/J) of the sensor (available on both the calibration certificate and the calibration sticker attached to the sensor cable), and the typical laser pulse energy.

7. If you know your expected laser pulse repetition rate, set the scope time base to show 2 pulses on the screen. This helps set the trigger and allows observation of the true "baseline" of the pulse. For example, for a laser running at 10 pps, set the scope time base to 20 msec/division. Once proper triggering occurs, use the vertical adjust to set the baseline of the EnergyMax voltage pulse to coincide with a horizontal grid line (see Figure 1). This setting becomes the zero for the peak voltage reading.

8. Adjust the "time base" of the scope to show a single EnergyMax pulse and then focus on the leading edge to accurately read the peak voltage (see Figure 2).

**To avoid affecting the calibration of the sensor with a coaxial cable do not lengthen the cable when using the sensor with the oscilloscope.**

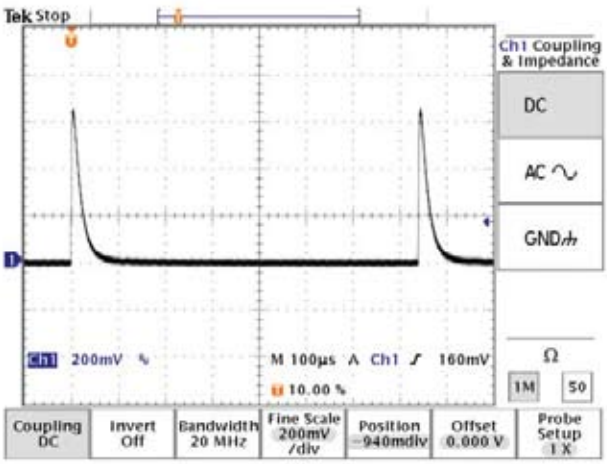



Figure 1

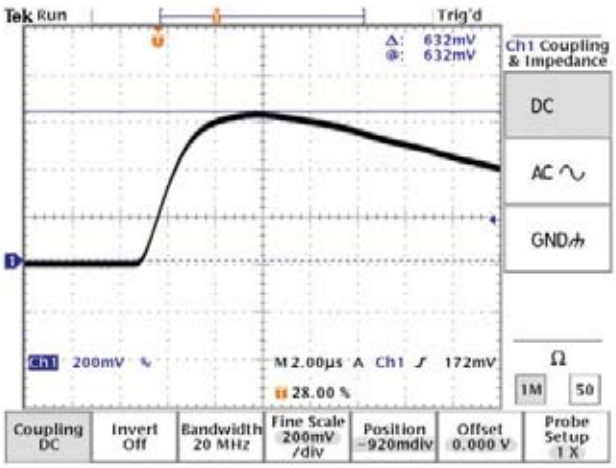



Figure 2

# Custom and OEM Products Introduction

## Complete Laser Measurement and Control Solutions

Laser system integrators frequently include laser measurement products in their systems to monitor system performance and status, or to provide real-time feedback for laser system control. In these instances custom measurement solutions or modifications to our existing products may be necessary due to size or performance constraints.

Coherent is well positioned to provide custom and modified measurement products. Following are some examples of services and products Coherent offers.

**OEM Power and Energy Sensors**
We provide an extensive line of OEM thermopile and energy sensors. Usually, a standard or existing modified standard product will fit your application.

Power Sensors
- Compact thermopile power sensors
- Water-cooled and air-cooled options
- BNC and 4-pin Molex signal output options
- Thermopile disks for integrating into heat-sinked applications
- Any standard thermopile with a cable can be integrated with an off-the-shelf interface module

Energy Sensors
- BNC-terminated energy sensors
- Compact designs to fit in tight locations
- A customer-supplied peak detection module or a Coherent meter or custom signal conditioning board is required

**Off-the-Shelf Interface Modules**
Several off-the-shelf electronic modules provide signal conditioning, measurement, and communication outputs.

Power Modules
- Amplification for very low power applications
- Noise filtering
- Analog output
- PC interfacing
- Beam position monitoring

Energy Modules
- Baseline and peak detection capabilities
- Noise filtering for greater peak detection accuracy
- Repetition rates as high as 100 kHz

**Custom Measurement Products**
Sometimes a completely custom product is required for a particular application. Our research and development teams of electrical, mechanical and software engineers, physicists, chemists and materials scientists can provide measurement systems to meet the most complex challenges. By involving Coherent early in your design phase we can provide the very best solution.

- Custom detectors and sensors
- Interface modules with unique communication protocols
- Extremely low energy and/or high repetition rate energy measurement

**Modified Standard Products**
Sometimes a slight modification to a standard catalog product is all that is needed to enable a special application.

Mechanical
- Longer or shorter cable
- Different type of connector
- Slight mechanical change

Calibration
- Different calibration wavelength

# OEM Modules



## PM-Digital

**Features**

- Compact, OEM power meter for embedded applications
- RS-232 PC interface
- LabVIEW instrument driver
- PC applications software
- Compatible with PM Model thermopiles
- Dimensions (H x W x D): 51 x 134 x 92 mm (2.0 x 5.2 x 3.6 in.)

| Part Number | Description |
|---|---|
| 0012-3550 | PM-Digital |

## SmartSensor Interface Module (SSIM)

**Features**

- Compact, OEM power meter for embedded applications
- RS-232, USB 1.1 PC interfaces
- PC applications software
- Displays beam position information
- Compatible with LM Model thermopiles
- Dimensions (H x W x D): 38 x 127 x 133 mm (1.4 x 5.0 x 5.2 in.)

| Part Number | Description |
|---|---|
| 1008557 | SmartSensor Interface Module (SSIM) |

## J100 Energy Sensor

**Features**

- Large-area 95 mm diameter
- Broad spectral response 0.3 to 12 µm
- Wide dynamic range of 0.4 mJ to 5J
- High average power to 20W

The J100 is a pyroelectric energy sensor with a flat, broad spectral response calibrated at 1064 nm. The 95 mm diameter active area is ideal for divergent sources and pulsed lasers used in applications such as laser range finding. The sensor output is through a BNC connector and the product ships with a 1.5 m BNC cable.

| Part Number | Description |
|---|---|
| 0011-6100 | J100 Energy Sensor |

# OEM Thermopiles

## 10 mW to 150W

Models PM10-19A, PM10-19B, PM150-50A

**Features**

- **10 mW to 150W**
- **Spectrally flat from 0.19 µm to 11 µm**
- **Compact designs**
- **Air-cooled or water-cooled**
- **Active area diameters from 19 mm to 50 mm**

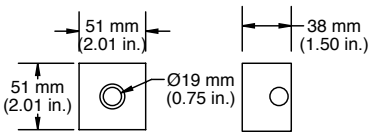
The sensors on the next two pages are small, compact OEM thermopiles designed for use in embedded applications. Power ratings are provided for water-cooled and air-cooled installations (see page 18 for additional air-cooled ratings for various exposure times). For conductively-cooled installations a good approximation is that doubling the surface area of the sensor housing doubles the air-cooled rating.

Models that end with "A" are amplified sensors with a 4-pin connector. They must be supplied with ±15 VDC and draw less than 20 mA. Models that end with "B" are passive sensors with a BNC output. Models with DB25 cables that are compatible with our instruments end with a "C" and can be found on page 30.

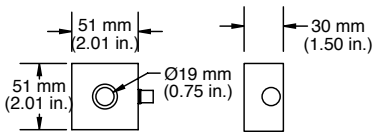
**Device Specifications**

| Model | PM10-19A | PM10-19B | PM150-19A | PM150-19B | PM150-50A |
|---|---|---|---|---|---|
| Wavelength Range (µm) | 0.19 to 11 | | | | |
| Resolution (mW) | 1 | 1 | 30 | 30 | 30 |
| Min. Water flow (gpm) | 0.02 | 0.02 | 0.2 | 0.2 | 0.2 |
| Max. Avg. Power (water-cooled) (W) | 10 | | 150 | | |
| Max. Avg. Power (air-cooled, 5 min.) (W) | 5 | | 20 | | 80 |
| Responsivity (typ.) | 1 V/W | 1 mV/W | 40 mV/W | 0.4 mV/W | 40 mV/W |
| Max. Power Density | 26 kW/cm² | | | | |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | | | |
| Response Time (sec.) | 1 | 2 | 1 | 2 | 1 |
| Detector Coating | Broadband | | | | |
| Active Area Diameter (mm) | 19 | | | | |
| Dimensions (mm) | 51 x 51 x 38 (2.0 x 2.0 x 1.4 in.) | 51 x 51 x 30 (2.0 x 2.0 1.1 in.) | 51 x 51 x 38 (2.0 x 2.0 x 1.4 in.) | 51 x 51 x 30 (2.0 x 2.0 1.1 in.) | 89 x 89 x 38 (3.5 x 3.5 x 1.4 in.) |
| Calibration Uncertainty (%) | ±1 | | | | |
| Calibration Wavelength (nm) | 514 | | | | |
| Cooling Method | Water-cooled | | | | |
| Connector Type | 4-pin Molex 22-12-2044 | BNC-terminated | 4-pin Molex 22-12-2044 | BNC-terminated | 4-pin Molex 22-12-2044 |
| Cable Length (m) | – | – | – | – | – |
| Part Number (RoHS) | 1098334 | 1098343 | 1098418 | 1098321 | 1098510 |

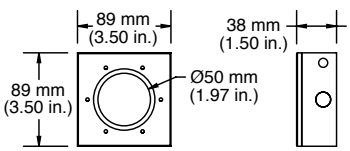
**PM10-19A/PM150-19A**




**PM10-19B/PM150-19B**




**PM150-50A**



# OEM Thermopiles

## 300 mW to 1 kW

Model PM150-50B, PM150-50XB, PM1K-36B, BeamFinder

**Features**

- 300 mW to 1 kW
- Spectrally flat from 0.19 µm to 11 µm
- Compact designs
- Air-cooled or water-cooled
- Active area diameters from 19 mm to 50 mm

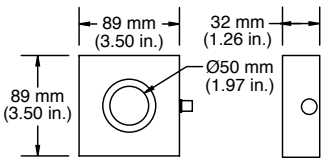
BeamFinder: Use with LabMax, Ultima, or LaserPAD (see pages 10-16)

**Device Specifications**

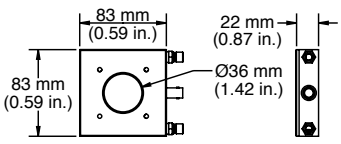
| Model | PM150-50B | PM150-50XB | PM1K-36B | BeamFinder[1] |
|---|---|---|---|---|
| Wavelength Range (µm) | 0.19 to 11 | 0.15 to 1 | 0.19 to 11 | 0.3 to 10.6 |
| Resolution (mW) | 30 | 30 | 1000 | 1000 |
| Min. Water flow (gpm) | 0.2 | 0.2 | 1.0 | 1.0 |
| Max. Avg. Power (water-cooled) (W) | 150 | | 1000 | |
| Max. Avg. Power (air-cooled, 5 min.) (W) | 80 | | 40 | – |
| Responsivity (typ.) | 0.4 mV/W | | 0.1 mV/W | – |
| Max. Power Density | 26 kW/cm² | | | 2.5 kW/cm² |
| Max. Energy Density | 0.6 J/cm², 1064 nm, 10 ns | | | 0.5 J/cm², 1064 nm, 10 ns |
| Response Time (sec.) | 5 | | | 10 |
| Detector Coating | Broadband | UV | Broadband | H |
| Active Area Diameter (mm) | 50 | | 36 | 35 |
| Dimensions (mm) | 89 x 89 x 32 (3.5 x 3.5 x 1.2 in.) | | 83 x 83 x 22 (3.2 x 3.2 x 0.8 in.) | 84 x 84 x 25.4 (3.3 x 3.3 x 1.0 in.) |
| Calibration Uncertainty (%) | ±1 | | ±5 | |
| Calibration Wavelength (nm) | 514 | | 1064 | 10,600 |
| Cooling Method | Water-cooled | | | |
| Connector Type | BNC-terminated | | | LM DB-25 |
| Cable Length (m) | – | – | – | 6 |
| Part Number (RoHS) | 1098415 | 1098441 | 1098333 | 1098427 |

[1] BeamFinder incorporates a quadrant thermopile disk that enables the position of the beam to be sensed.

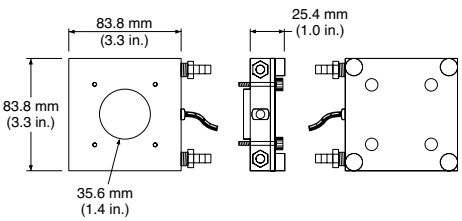
**PM150-50B/PM150-50XB**




**PM1K-36B**




**BeamFinder**




* Requires 15 VDC power input

# Custom and OEM Products

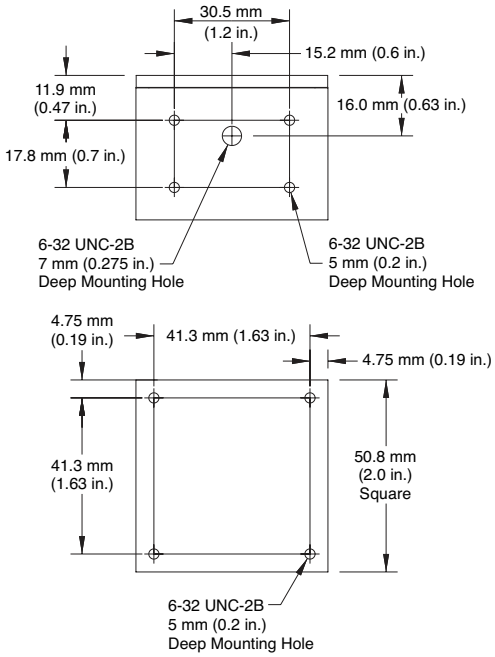
## Complete Laser Measurement and Control Solutions

Additional electrical connection, water fitting, and mounting details for several of our OEM thermopiles can be found below.

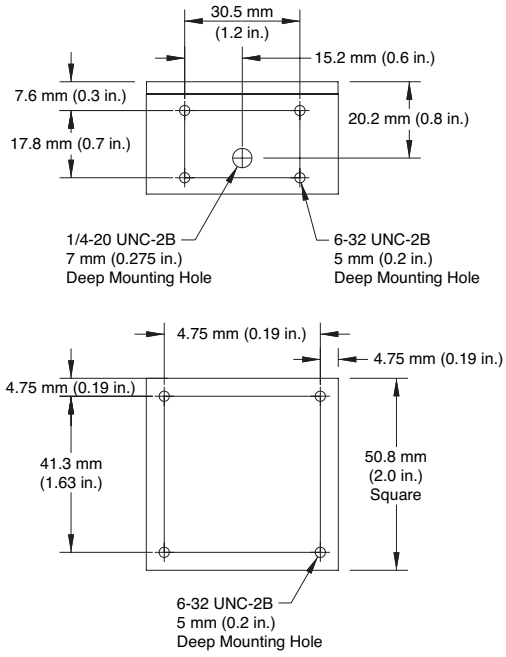
**PM10-19A, PM150-19A, PM150-50A**
Style: Active amplified output
Input/Output connector: 4-pin, Molex part no. 22-12-2044
pin 1: -10 to -20V power input
pin 2: Ground
pin 3: +10 to +20V power input
pin 4: Output signal
Current draw: Approx. 8 mA at -15 V, Approx. 18 mA at +15 V
Output impedance: 100 Ohm
Water connections: 1/8 NPT

**PM10-19B, PM150-19B, PM150-50B, PM150-50XB, PM1K-36B**
Style: Passive output
Output connector: BNC
Output impedance: 2500 Ohm
Water connections: 1/8 NPT

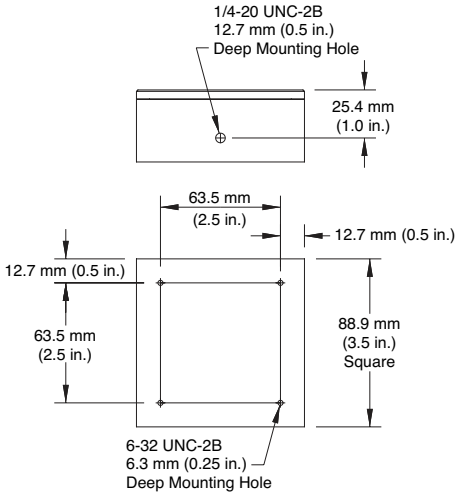
**PM10-19A/ PM150-19A**



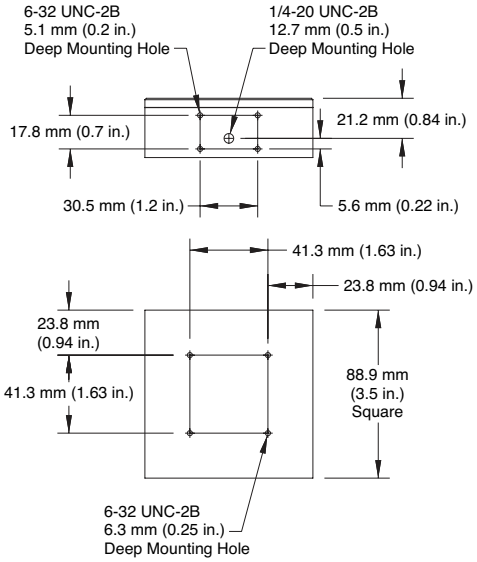

**PM10-19B/ PM150-19B**




**PM150-50A**




**PM150-50B/ PM150-50XB**

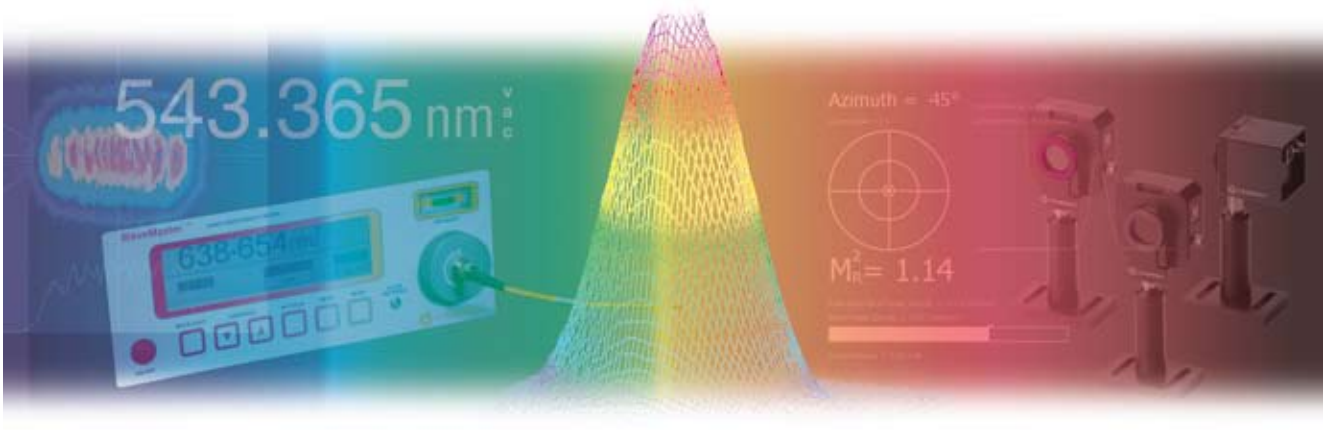


# Beam Diagnostics Introduction

## Introduction to Laser Beam Diagnostics



In today's fast-paced photonics market it is important to understand the technical specifications of highly complex laser systems and their applications. As well as analyzing the power or energy, it is also useful to understand the shape, intensity profile, and propagation of a laser beam. For over 25 years Coherent has developed precision instruments that measure, characterize, and monitor these laser parameters for thousand of customers around the world.




### Beam Profilers

As a laser beam propagates, changes in the laser cavity, as well as changes in divergence and interactions with optical elements, cause the width and spatial intensity of the beam to change in space and time. Spatial intensity distribution is a fundamental parameter for indicating how a laser beam will behave in any application. And while theory can sometimes predict the behavior of a beam, tolerance ranges in mirrors and lenses, as well as ambient conditions affecting the laser cavity and beam delivery system, necessitate verification.

Two types of beam profilers are available: those that use special cameras as the beam detectors (these are excellent for fast and detailed analyses of the intensity profile of pulsed and CW lasers); and systems that use moving knife-edges (these have a large dynamic range and can accurately measure small and focused beams). Coherent has both of these types available: the camera-based BeamView Analyzer on page 62 and an advanced knife-edge system—BeamMaster—on page 71.

### Beam Propagation

The Coherent ModeMaster beam propagation analyzer established an entirely new laser beam quality parameter that is now an ISO standard. $M^2$ is recognized as describing both how "close-to-perfect Gaussian" a beam is, and also how well the beam can be focused at its intended target.

### Wavelength Meter

For many high performance tunable laser systems, or those using laser diodes, it is important to measure the wavelength. The WaveMaster laser wavelength meter accurately measures the wavelength of both CW and pulsed lasers of any repetition rate to an accuracy of 5 picometers. See page 80 for additional specifications for the WaveMaster.

**Summary of Product Primary Measurement Capabilities**

| Model | BeamView Analyzer | BeamMaster | ModeMaster | WaveMaster |
|---|---|---|---|---|
| Wavelength | – | – | – | CW + Pulsed |
| Power / Energy | – | CW | – | – |
| Beam Position | CW + Pulsed | CW | CW | – |
| Propagation $M^2$ | – | – | CW | – |
| Beam Profiles | | | | |
| 2D | CW + Pulsed | CW | CW | – |
| 3D | CW + Pulsed | CW | – | – |
| Page Number | 62 | 71 | 74 | 80 |

# LaserCam-HR

## Introduction to Camera-Based Beam Diagnostics

Coherent BeamView Analyzer systems are the recognized leader in software, hardware and optical components for laser beam analysis. Constant product improvement based on customer feedback, and innovation from beam analysis experts, have made BeamView Analyzer products the first choice for laboratory, factory and field measurements.

The key elements of a typical camera-based beam profiling system are the camera itself, Coherent Beamview analysis software running on an appropriate computer and, when necessary, beam attenuation optics. The key choice to make is matching the appropriate camera technology to your application.

Coherent beam diagnostic cameras are specifically designed or modified for laser analysis. They provide low noise, maximum linearity, and uniformity of response—needed for maximum measurement accuracy. All of these diagnostic cameras accept C-Mount optical accessories and are delivered without a cover (glass/plastic window) over the sensor array. Instead, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera—a laser-grade neutral density filter made of glass specified and polished specifically for laser diagnostic analysis. The LDFP filter is mounted in a standard C-Mount ring and provides attenuation of ambient room light so that the camera can be used with normal room lights.

Coherent offers three families of cameras. Lasercam II and LaserCam IIID cameras use analog and digital interfacing respectively. The latest edition, LaserCam HR, is based on USB technology.

**USB 2.0 Beam Diagnostic Camera Family**
Coherent pioneered the ease-of-use of digital USB 2.0 bus-powered, high-resolution, large-area cameras requiring only a single cable for both video transfer and camera power. The LaserCam-HR family of beam diagnostic cameras now includes the LaserCam-HR-UV and the LaserCam-HR-InGaAs models, extending the measurement spectrum from the deep ultraviolet to the near-infrared wavelengths.

The same features, performance and convenience previously available only for wavelengths covered by the LaserCam-HR are now available to users of excimer lasers, telecommunication sources and military laser systems. With a broad spectral range covering 190 nm to 1700 nm, there is a LaserCam-HR camera profiler system ideally suited for nearly any demanding laser measurement application.

**Important Considerations**
- Ease-of-use connectivity
  - High-speed USB 2.0 Interface
  - USB bus-powered low voltage operation
- Broad spectral range
  - LaserCam-HR 300 nm to 1100 nm (400 to 1100 nm with LDFP)
  - LaserCam-HR-UV DUV to 355 nm
  - LaserCam-InGaAs 900 nm to 1700 nm
- Large dynamic range
- Coherent Adaptive Pixel Technology (CAPT)
- Digital output through USB 2.0 eliminates the need for an interface card (frame-grabber)
- High-accuracy beam diameter calculations
- Excellent beam spatial uniformity
- BeamView 4.4 application software

- Variable camera exposure time
- Compact size
- High-speed image capture rates (15 to 25 frames per second)
- Pass/Fail TTL level output
- RS-232 and TCP/IP communication protocols
- Comprehensive LabVIEW library suite for the majority of BeamView-USB software functions
- All LaserCam-HR camera systems are RoHS compliant

**Coherent Adaptive Pixel Technology**
Coherent tests each LaserCam-HR camera through a process called CAPT (Coherent Adaptive Pixel Technology). This uses a calibrated lightsource and a digital look-up table to give pixel-to-pixel linearity correction. In addition, any identified "hot" pixel is corrected by averaging the value of the four directly surrounding pixel intensities. Finally, the noise levels are carefully monitored through both a background noise subtraction and a user-selectable bias noise offset level. The CAPT process optimizes the performance of the camera array, directly improving beam measurement accuracy, especially with beam diameter calculations.

Multiple channel camera support of different LaserCam-HR camera models is available for all three LaserCam-HR camera types (UV, visible, and InGaAs).

Variable camera exposure time available with the entire LaserCam-HR camera family allows imaging of higher repetition rate sources and lets the user decrease/increase the signal intensity levels using exposure time instead of external attenuation. This feature is especially suited for the LaserCam-HR-InGaAs, with its impressive spatial uniformity characteristics.

# Beam Diagnostic Cameras

## LaserCam-HR and LaserCam-HR-UV

LaserCam-HR

LaserCam-HR-UV

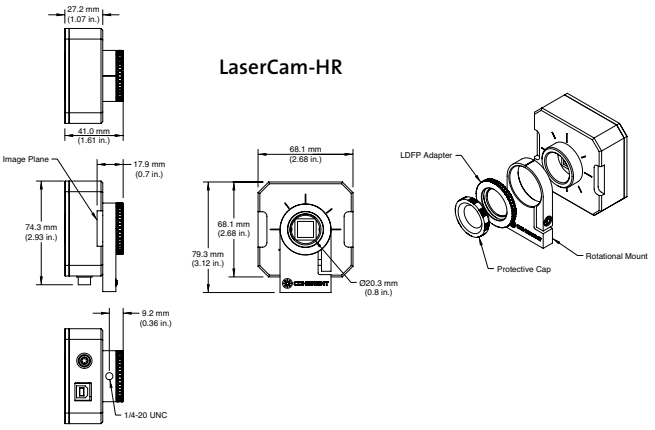
**Features**

- **USB 2.0, 10-bit digital output**
- **Large-area CMOS array, 8.5 x 6.8 mm**
- **Compact 68 x 68 x 34 mm package**
- **Coherent Adaptive Pixel Technology (CAPT) pixel-by-pixel offset, linearity and blemish correction**
- **CW and pulsed operation including external triggering**
- **Variable exposure time**
- **User-variable trigger delay**
- **Long-term UV sensor stability (with the LaserCam-HR-UV camera)**

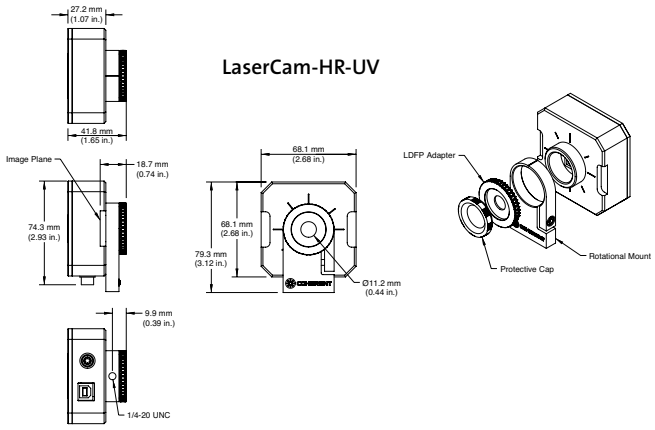
**Device Specifications**

| Model | LaserCam-HR | LaserCam-HR-UV |
|---|---|---|
| Sensor Elements (pixels) | 1280 x 1024 | |
| Effective Pixel Resolution (µm) | – | 20 x 20 |
| Pixel Size (µm) | 6.7 x 6.7 | |
| Sensor Active Area (mm)(H x V) | 8.5 x 6.8 (2/3 inch format) | |
| Spectral Range (nm) | 300 to 1100<br>400 to 1100 (with LDFP) | 190 to 355 |
| Beam Diameters (mm) | 0.2 to 6.0 | 0.5 to 6.0 |
| Glassless Sensor | Low Distortion Face Plate is removable | |
| Low-Distortion Face Plate (LDFP, LDFP-UV) | Laser-grade ND filter, OD = 2.5 at 632.8 nm | UV-grade ND filter, OD = 3.0 at 248 nm |
| Electrical Interface | USB 2.0 | |
| Capture Modes | Continuous (CW), pulsed | Continuous (CW), pulsed |
| Variable Exposure Time | 1 msec to 1 sec, default at 10 msec | |
| Pulsed Mode Trigger Methods | Trigger In (TTL) | |
| Maximum Pulse Trigger in Rate (Hz) | 100 (without averaging adjacent pulses) | |
| Maximum Frame Rate (FPS) | | |
| Live video, no calculations | 15 | 20 |
| Capture with calculations | 10 | 15 |
| Damage Threshold | 32 mJ/cm² (without LDFP) at 1064 nm | 200 µJ/cm² (without LDFP-UV) at 248 nm |
| CW Saturation | 40 mW/cm² (with LDFP) at 633 nm<br>16 µW/cm² (without LDFP) at 633 nm<br>800 mW/cm² (with LDFP) at 1064 nm<br>320 µW/cm² (without LDFP) at 1064 nm | 90 mW/cm² (with LDFP-UV) at 248 nm<br>90 µW/cm² (without LDFP-UV) at 248 nm |
| Pulsed Saturation | 8 mJ/cm² (with LDFP) at 1064 nm<br>3.2 µJ/cm² (without LDFP) at 1064 nm | 5 mJ/cm² (with LDFP) at 248 nm<br>5 µJ/cm² (without LDFP) at 248 nm |
| USB 2.0 Cable | 6 ft. standard A/B cable included | |
| Trigger Connector | BNC receptacle (trigger cable included) | |
| Part Number | 1098577 | 1149004 |

**LaserCam-HR**




**LaserCam-HR-UV**



# Beam Diagnostic Cameras

## LaserCam-HR-InGaAs

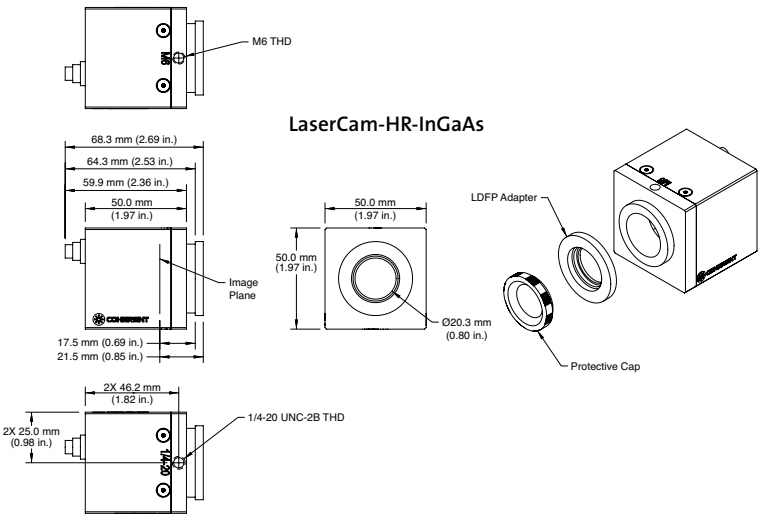
LaserCam-HR-InGaAs

**Features**

- USB 2.0 large-area, InGaAs sensor, 9.6 mm x 7.7 mm
- 14-bit digital output providing >1000:1 optical dynamic range
- Outstanding linearity error of <1%
- 30 µm x 30 µm pixel pitch
- Compact 50 x 50 x 68 mm package
- CW and pulsed operation including external triggering
- Coherent Adaptive Pixel Technology (CAPT) pixel-by-pixel offset, linearity and blemish correction
- Variable exposure time, 20 µsec to 25 msec
- User variable trigger delay

**Device Specifications**

| Model | LaserCam-HR-InGaAs |
|---|---|
| Sensor Elements (pixels) | 320 x 256 |
| Pixel Size (µm) | 30 x 30 |
| Sensor Active Area (mm)(H x V) | 9.6 x 7.7 |
| Spectral Range (nm) | 900 to 1700 |
| Beam Diameters (mm) | 0.5 to 6.0 |
| Glassless Sensor | Low Distortion Face Plate is removable |
| Low-Distortion Face Plate (LDFP) | Laser-grade ND filter, OD = 2.5 at 632.8 nm |
| Electrical Interface | USB 2.0 |
| Capture Modes | Continuous (CW), pulsed |
| Variable Exposure Time | 20 µsec to 25 msec, default at 1 msec |
| Pulsed Mode Trigger Methods | Trigger In (TTL) |
| Maximum Frame Rate (FPS) | 25 (live video, no calculations), 15 (capture with calculations) |
| Saturation | |
| CW (at 1064 nm) | 3.5 mW/cm² (with LDFP), 50 µW/cm² (without LDFP) |
| CW (at 1523 nm) | 350 µW/cm² (with LDFP), 30 µW/cm² (without LDFP) |
| Pulse (at 1064 nm) | 5 µJ/cm² (with LDFP), 0.08 µJ/cm² (without LDFP) |
| USB 2.0 Cable | 6 ft. standard A/B cable included |
| Trigger Connector | BNC receptacle (trigger cable included) |
| Part Number | 1149002 |



# Beam Diagnostic Cameras

## Additional Digital and Analog CCD Cameras

LaserCam-IIID Digital Camera

**Features**

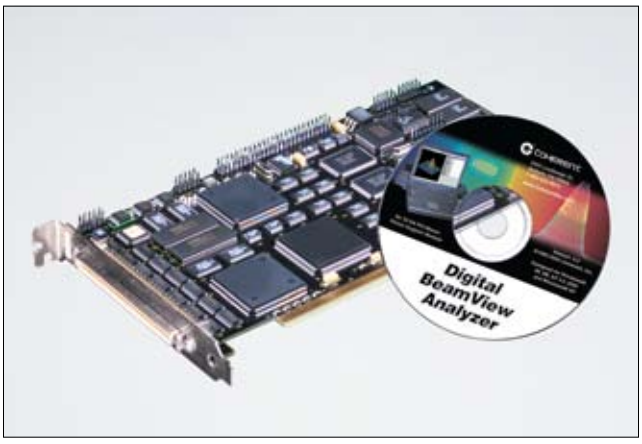
- **CW operation and single-pulse capture rates to 10 kHz**
- **1/4" and 1/2" CCD active sensor sizes**
- **Spectral range of 190 nm to 1100 nm**
- **Pixel resolution down to 5 µm**
- **High optical dynamic range**
- **Cameras specifically designed for laser beam analysis**

The LaserCam-IIID, LaserCam-II, and the P-TM7 provide outstanding laser beam analysis, but require the use of an interface (frame-grabber) card for image capture prior to software analysis.

The LaserCam-IIID digital camera is designed and sold only as a system, together with the frame-grabber, BeamView 3.2 software package, and a video/trigger cable. Reference the Digital and Analog Camera Selection Chart on the next page for detailed specifications, and camera or system part numbers.

Coherent's 8-bit analog CCD cameras (LaserCam II and P-TM7) are sold independently from the software and frame-grabber package. To assemble an Analog Camera system, first order the frame grabber, BeamView analyzer software and cables as item number 33-2700-00. Then add an analog camera from the table on Page 61. All analog cameras have RS-170 video output (60 Hz field rate) and include a switching power supply that operates from 100 to 240 VAC (50/60 Hz).

LaserCam-II Camera




LaserCam-IIID frame-grabber and BeamView software

# Beam Diagnostic Cameras

## Additional Digital and Analog Cameras

LaserCam-IIID, LaserCam-II, P-TM-7

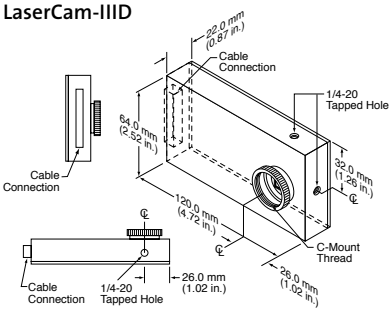
### Features

- 190 nm to 1100 nm spectral range
- 1/2" and 1/4" CCD camera for laser beam profiling
- 10-bit digital output with LaserCam-IIID
- 8-bit analog output for LaserCam-II and P-TM7 (requires an external frame-grabber, part no. 33-2700-000)
- 6.4 x 4.8 mm sensor area 1/2" LaserCam-IIID
- 8.5 x 9.8 µm pixel pitch 1/2" LaserCam-IIID
- 3.6 x 2.7 mm sensor area 1/4" LaserCam-IIID
- 4.8 x 5.5 µm pixel pitch 1/4" LaserCam-IIID
- LaserCam-IIID interfaces to BeamView Digital 3.2.x
- LaserCam-II and P-TM7 interface to BeamView Analog 2.4.x

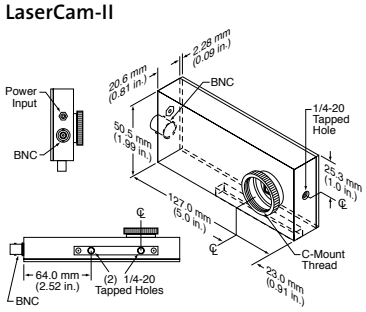
| Model | LaserCam-IIID 1/2" | | LaserCam-IIID 1/4" | | LaserCam-II 1/2" | | LaserCam-II 1/4" | | P-TM7 1/2" | |
|---|---|---|---|---|---|---|---|---|---|---|
| Format | Digital Interline Transfer CCD | | Digital Interline Transfer CCD | | Analog RS-170 Interline Transfer CCD | | Analog RS-170 Interline Transfer CCD | | Analog RS-170 Interline Transfer CCD | |
| Sensor Elements (H x V) | 736 x 484 | | | | | | | | | |
| Wavelength Range (nm) | 190 to 1100 | | 190 to 1100[1] | | 190 to 1100 | | 190 to 1100[1] | | 190 to 1100 | |
| Maximum Active Sensor Area (mm) | Horz. 6.4 | Vert. 4.8 | Horz. 3.6 | Vert. 2.7 | Horz. 6.4 | Vert. 4.8 | Horz. 3.6 | Vert. 2.7 | Horz. 6.4 | Vert. 4.8 |
| Digitized Resolution: | | | | | | | | | | |
| Frame Mode (µm) | 8.5 | 9.8 | 4.8 | 5.5 | 8.4 | 9.8 | 4.8 | 5.6 | 8.4 | 9.8 |
| Full-Field Mode (µm) | 17 | 19.6 | 9.6 | 11 | 16.8 | 19.6 | 9.6 | 11.3 | 16.8 | 19.6 |
| Half-Field Mode (µm) | 34.0 | 39.2 | 19.2 | 22 | 33.6 | 39.2 | 19.2 | 22.6 | 33.6 | 39.2 |
| Min. Beam Size (µm) | 0.34 | 0.40 | 0.19 | 0.22 | 0.34 | 0.40 | 0.19 | 0.22 | 0.34 | 0.40 |
| Dynamic Range | >2000:1 | | >2000:1 | | >300:1 | | >300:1 | | >250:1 | |
| CW Saturation (without LDFP) (µW/cm² at 632.8 nm) | 0.5 | | 0.5 | | 0.8 | | 0.8 | | 0.8 | |
| Pulsed Saturation (without LDFP) (µW/cm² at 632.8 nm) | 9.1 | | | | | | | | | |
| Electronic Shutter (ms) | 30, 60 to 1500 (continuous adjustment)[2] | | | | 16.6 (open shutter), 10, 8, 4, 2, 1, 0.5, 0.25, 0.1 | | | | 16.6 (open shutter), 8, 4, 2, 1, 0.5 | |
| Field Rate (Hz) | 60 | | | | | | | | | |
| Software Required | – | | – | | BeamView Analog Analyzer System w/PCI Interface Card | | BeamView Analog Analyzer System w/PCI Interface Card | | BeamView Analog Analyzer System w/PCI Interface Card | |
| Part Number | 33-7006-000 | | 33-6990-000 | | 33-3120-000 | | 33-2965-000 | | 33-3203-000 | |

[1] The 1/4" and 1/2" LaserCam-IIID and LaserCam-II cameras cannot be used with pulsed beams from 900 to 1100 nm.
[2] CW operation only.

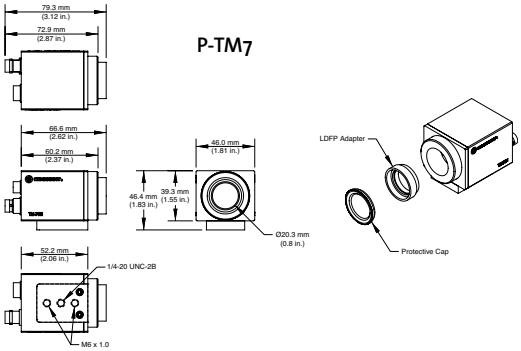
**LaserCam-IIID**




**LaserCam-II**



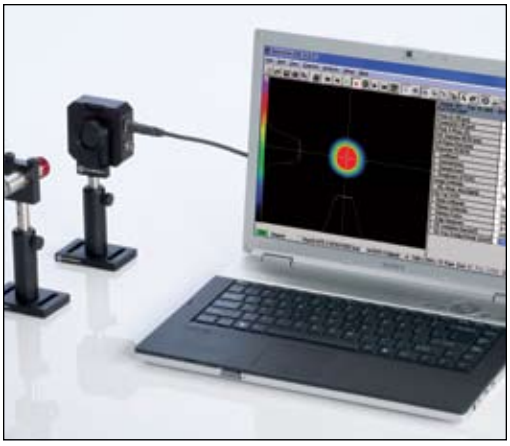

**P-TM7**



# BeamView Analyzer Software

## Introduction to BeamView-USB Software





**Features**

- **High-speed USB 2.0 camera interface (BV-USB software only)**
- **Supports all three LaserCam-HR camera types**
- **Remote control interface**
- **Over 30 numerical analysis functions**
- **Multiple image import and export formats**
- **Automatic background noise subtraction**
- **Pass/Fail fault settings, alarms, configurable setups**
- **Easy-to-use, intuitive user interface**
- **Windows XP and Vista (32-bit; BeamView USB software only)**

To monitor, analyze and archive laser beam images, BeamView Analyzer software is recognized as the leading laser beam profiling software. It has been designed to provide the maximum flexibility, speed, and user friendliness. Coherent offers three BeamView Analyzer software packages for maximum flexibility: BeamView Analog 2.4 is supplied along with the frame-grabber card required for use with analog cameras. BeamView Digital 3.2 is provided along with LaserCamIIID digital cameras. BeamView-USB 4.4 is included with all LaserCam-HR USB 2.0 cameras and provides additional new features.

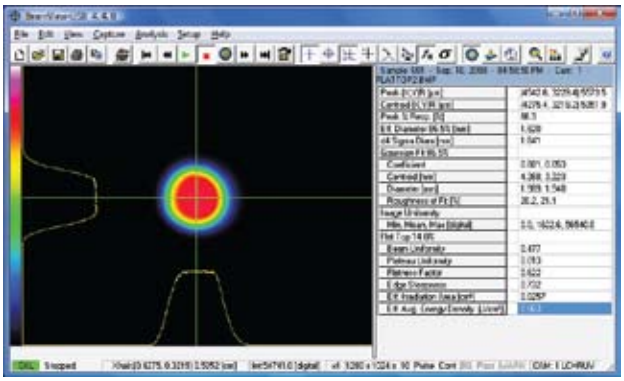
## BeamView-USB Analyzer Software

**BeamView-USB Analyzer Software**
The latest release of the BeamView-USB 4.4 software includes several new features that extend the analytic capabilities of the LaserCam-HR laser beam diagnostic systems. These new features, not available with Analog or Digital BeamView Analyzer Software, include:

- Supports both 10-bit and 14-bit LaserCam-HR camera types
- Multiple LaserCam-HR camera types can be connected to a single system
- Flat-top beam analysis
- Adjustable trigger delay
- Report generation
- Variable exposure time
- LabVIEW drivers
- RS-232 and TCP/IP remote communication protocols

**Flat-Top Beam Analysis**
Six additional calculations are now available with BeamView-USB software for flat-top beam analysis. These calculations are based on the ISO 13694:2000 standards. The six calculations allow greater flexibility for the analysis of applications involving flat-top beam shapes. They also may assist in the analysis of beam uniformity of excimer and Nd:YAG lasers in the near field. The six new calculations are:

- Plateau Uniformity
- Flatness Factor
- Edge Steepness
- Beam Uniformity
- Effective Irradiation Area
- Effective Average Power/Energy Density



Screen shot of a flat-top beam image

Image of dialog box for flat-top calculations.

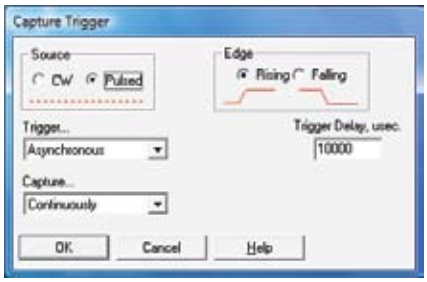
# BeamView Analyzer Software

## BeamView Analyzer Software Features

**Adjustable Trigger Delay**
A new adjustable Trigger Delay feature in the BeamView-USB 4.4 software lets users add default trigger delay to the LaserCam-HR camera. This assists by providing additional flexibility when firing the camera from an external trigger source such as the SYNC Output of a laser.

**Adjustable Exposure Time**
The camera exposure time is adjustable through the camera settings menu for all LaserCam-HR camera models. Refer to page 57 for additional information on this feature.

**Report Generation**
BeamView-USB includes a single-page report that can be sent directly to a printer, saved to a file (.txt), or converted to an Adobe .pdf file by using a pdf file converter. A simple screen print option is available from the same friendly dialog box used to generate a report.




Screen shot of Capture/Trigger dialog box showing Trigger Delay setting

## BeamView Digital Analyzer Software

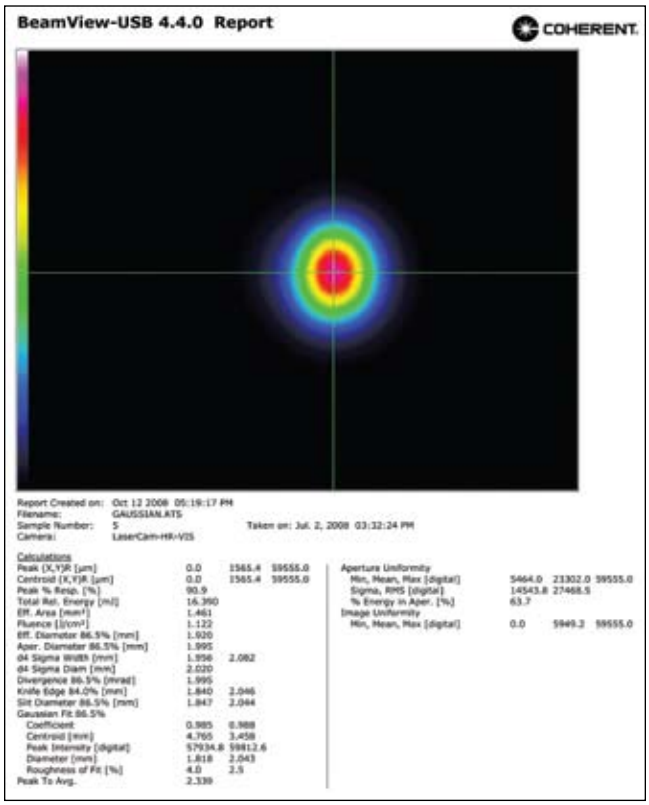
The BeamView Digital Analyzer system comes as a complete package, including a LaserCam-III 10-bit digital CCD camera, digital PCI interface card, BeamView Analyzer software, cables, and manual. For details on the LaserCam-IIID camera specifications, see pages 60 to 61.

## BeamView Analog Analyzer Software

The BeamView Analog Analyzer system includes a PCI interface card for use with either a RS-170 or CCIR 8-bit analog camera, cables, software, and manual. An analog camera must be ordered with the BeamView analog system. For a complete list of analog cameras specifically designed for laser beam profiling, see pages 60 to 61.

The analog version of the BeamView Analyzer software includes most features and capabilities found in both digital BeamView Analyzer platforms, but the analog version allows different types of cameras for beam profiling applications from 190 nm up to 2200 nm.

**BeamView System Performance Optimization**
All BeamView Analyzer software provides several functions that optimize the optical dynamic range available in the camera to achieve maximum measurement accuracy. The Automatic Background subtraction feature measures and stores the background noise "image" and automatically subtracts individual pixel noise levels from all subsequent laser images prior to analysis. The system also automatically monitors the background noise level to warn of changes that may effect measurement accuracy. The Automatic A/D Offset and Gain adjust feature (analog systems only) insures the A/D converter on the frame-grabber board is properly adjusted to match the maximum video signal and the background noise level for the analog camera being used.

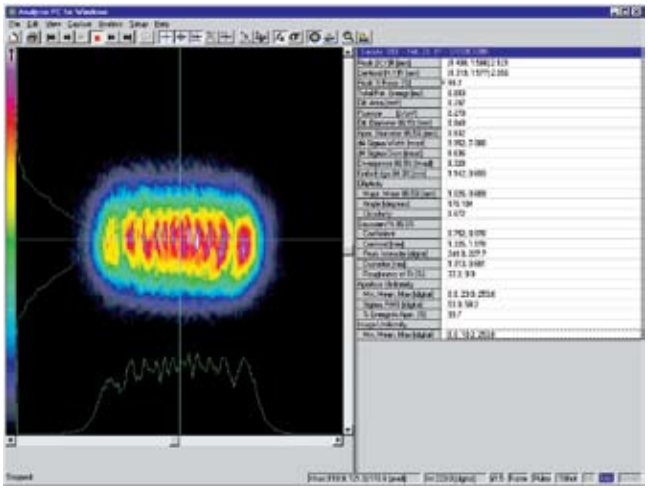


Screen shot of Print Screen dialog box and actual report

# BeamView Analyzer Software

## BeamView Analyzer Software Features

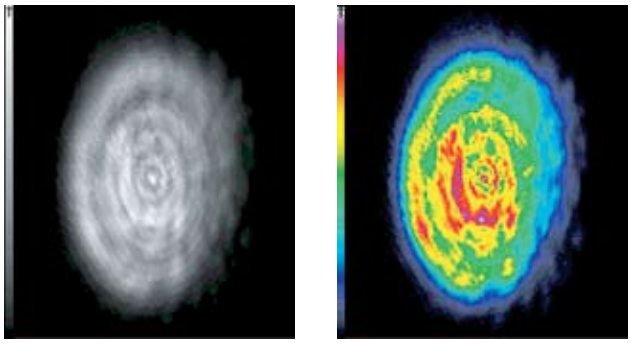




**BeamView Analyzer Software Additional Features**
The following BeamView Analyzer features are common among all three BeamView software platforms:

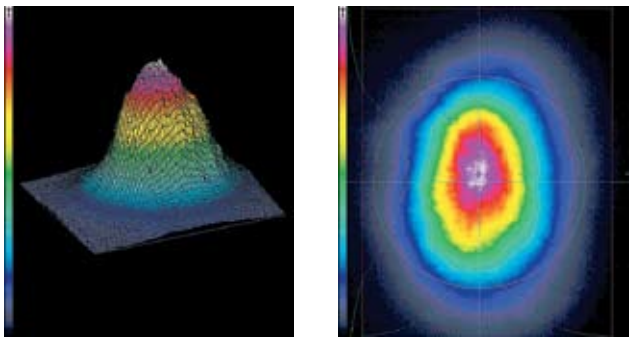
- **More than 25 different numerical analysis functions**
- **Several different profile views**
- **Multiple image import and export formats**
- **Import and export of results data and profile data**
- **Pass/Fail settings and user-selectable fault actions**

**Real-Time Laser Monitoring and Alignment**
The Live Video mode provides a continuously updated image of the beam (~20 Hz to 25 Hz, depending on the speed of the processor) displayed in shades of gray or pseudo-color. This mode is ideal for monitoring the laser and observing changes in the form and structure of the beam as it is adjusted. It also allows for real-time tuning to achieve optimum beam profile quality and laser-cavity alignment. While operating in this mode, no beam or statistical data are displayed, but if Run is activated, the image is stored and can be analyzed later.

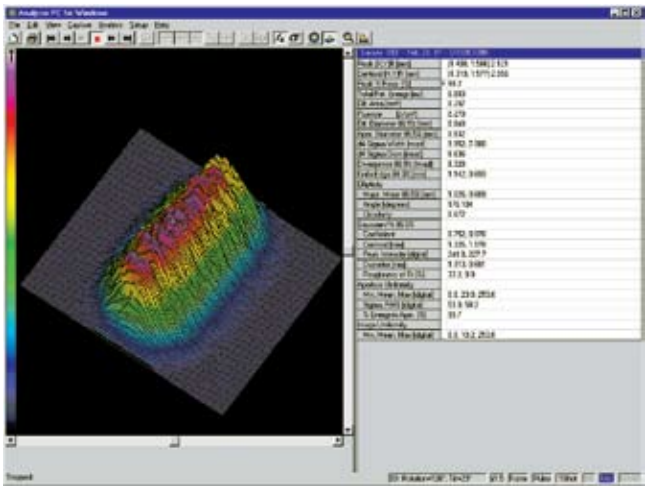


The Live Video mode

**2D and 3D Intensity Plots**
The Run command switches the BeamView Analyzer from the Stop or Live Video mode to continuous operation, which provides capture, analysis and display of beam image data. The view area of the computer monitor provides a choice of 2D or 3D images. The 2D contour maps and the 3D isometric plots display laser beam intensity profiles in a choice of color and gray-scale styles (fixed and autoscaling to a peak) and sizes (continuous zoom and pan control). The 2D maps can be shown with or without profiles (and Gaussian fit), reference position, variable aperture and rotatable crosshairs (with auto peak and auto centroid location). The 3D isometric plots can be displayed with transparent, hidden or solid wires, and can be rotated and viewed from different tilt angles.



Choice of 3D and 2D images



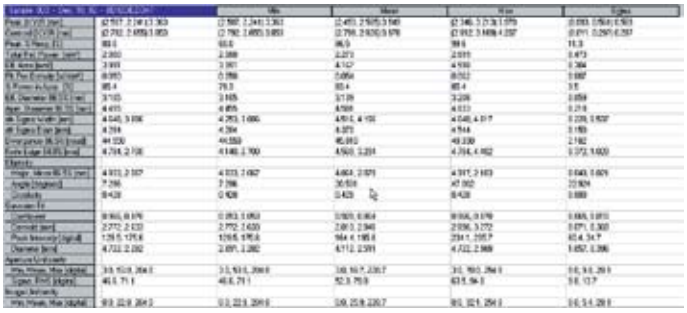
BeamView Analyzer display with 3D image and ISO-compatible results

# BeamView Analyzer Software

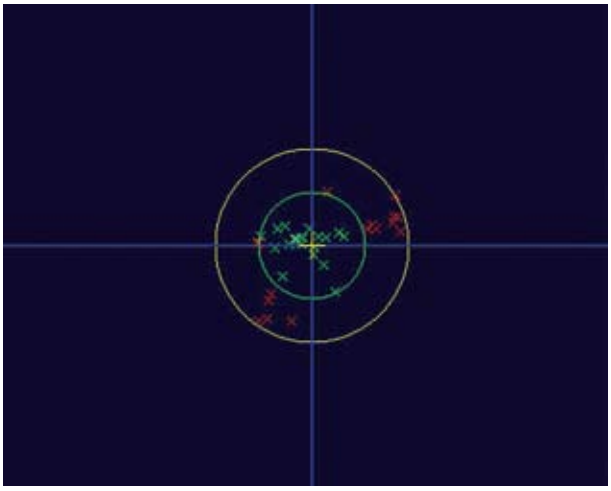
## BeamView Analyzer Software Features

### Beam Stability

The continuous on-line statistical analysis display shows results of all, or a combination of, functions and pass/fail parameters for all captured samples and accumulated results. The user can scroll through the analysis results of individual images, and also view the minimum, maximum and sigma (standard deviation) values. This makes comparing individual samples to the time-dependent statistical data easy. Thus, the jitter and stability of parameters, such as power, energy, pointing direction, ellipticity and beam size, etc., can be analyzed simultaneously with a polar beam wander plot.



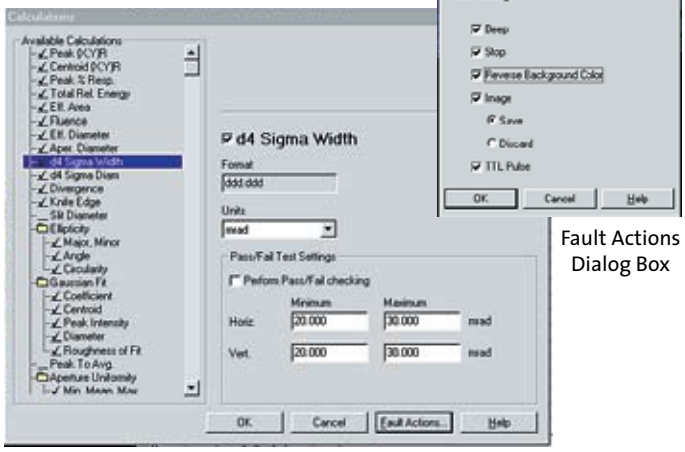
Continuous on-line statistical analysis display



Polar beam wander plot screen

### Pass/Fail Analysis

Pass/fail analysis allows simultaneous real-time monitoring of all, or any one of the analysis results against user-specified minimum/maximum limits. Any combination of, or all the fault actions can be activated to signal a test failure, initiate a visual alarm, an audio alarm, stop data capture, reject/save a failed sample, and generation of a TTL trigger pulse output signal.




Fault Actions Dialog Box

Calculations Pass/Fail test settings

### Remote Control

The BeamView Analyzer provides remote control and data transfer through the host computer's RS-232 (and TCP/IP with BeamView-USB). A complete control and data transfer command set is provided to allow users to develop their own remote control application for interfacing with the BeamView Analyzer software platform. The BeamView-USB software package includes a full suite of LabVIEW libraries for remote access to most BeamView features at a host computer running LabVIEW.

### Beam Analysis and Statistics

BeamView Analyzer software calculations are compatible with the International Standards Organization (ISO) guidelines for laser beam measurement:

- Peak and centroid beam position
- Beam ellipticity including angular position and major/minor axis information
- Circularity
- D4σ diameters and widths
- Guassian fit including coefficient, centroid, and "roughness of fit"
- Aperture fit and uniformity
- Total/relative power
- Peak power/energy density
- Percent power within an aperture

The BeamView analyzer system also includes several other analysis features listed in the BeamView Analyzer Software Features Summary on page 66.

# BeamView Analyzer Software

## BeamView Analyzer Software Features Summary



**Analysis, On-Line Pass/Fail Tests**

- **Centroid position/wander**
- **Peak intensity/position**
- **Peak-to-average intensity**
- **Beam diameter/widths (selectable):**
  - Second moment (δ4 Sigma)
  - Knife-edge
  - Slit
  - Aperture diameter
  - Effective diameter
- **Flat Top analysis (new in BeamView-USB 4.4.0):**
  - Beam uniformity
  - Plateau uniformity
  - Flatness factor
  - Effective irradiation area
  - Edge steepness
  - Effective average power/energy Density
- **Gaussian fits with:**
  - Correlation coefficient
  - Diameter
  - Centroid
  - Peak intensity
  - Fit roughness
- **Ellipticity at intensity slice:**
  - Major and minor axis diameter
  - Circularity (major/minor)
  - Axis orientation (rotation)
  - Auto align profiles to axis
- **Aperture analysis for circular, square, rectangular and elliptical beams:**
  - % power/energy in aperture
  - Uniformity in aperture
  - Aperture/diameter tracking
- **Selectable calculation area**
- **On-line statistical analysis (all results):**
  - Minimum, average, maximum
  - Sigma (standard deviation)
- **Pass/Fail test with fault action (all results):**
  - Ratio
  - Audio/visual alarms
  - Save/reject images
  - TTL pulse out
  - Stop data capture
- **Image averaging**
- **Peak energy/power density**
- **Relative energy/power**
- **Effective area**
- **Divergence at % energy/power**

---

**Interactive Display Functions**

- **On-line help**
- **Report generation (new in BeamView-USB 4.4.0):**
  - Report (.pdf)
  - BeamView window (screen capture)
- **Stored image paging**
- **Reference profile select**
- **Reference coordinate set**
- **Background subtraction**
- **Run/stop data analysis**
- **Control of cursors, profiles, aperture, position, rotation and size**
- **Live video on/off**
- **7 zoom levels**
- **Image and profile autoscale modes**
- **Auto peak/centroid locate**
- **A/D converter control (analog only)**
- **"Hot" function keys**

# BeamView Analyzer Software

## BeamView Analyzer Software Features Summary

### Image Capture and Storage

- Pulsed or CW (continuous) analysis
- Multi-channel (not simultaneous) camera input
- Support for multiple camera types (new in BeamView-USB 4.4.0)
- Adjustable camera exposure time (new in BeamView-USB 4.4.0)
- Image storage to:
  - PC RAM drive
  - PC hard drive
- RS-232 and TCP/IP communication protocols
- Comprehensive suite of LabVIEW libraries
- Multiple trigger modes:
  - External (asynchronous, trigger input)
  - Autotrigger to a selected level
  - Synchronous (trigger output, BeamView Digital and Analog software only)
- 3 resolution modes with BeamVIew-USB 4.4.x with the LaserCam-HR and LaserCam-HR-UV cameras:
  - 1280 x 1024 x 10
  - 640 x 512 x 10
  - 640 x 512 x 8
- 1 resolution mode with BeamView-USB 4.4.x with the LaserCam-HR-InGaAs camera:
  - 320 x 256 x 14
- 3 resolution modes with BeamView Digital and Analog (RS-170):
  - Frame (752 x 480 pixels)
  - Full-Field (376 x 240 pixels)
  - Half-Field (188 x 120 pixels)
- Various capture modes:
  - Continuous
  - Time interval
  - On command (keypress)
- High-speed sample mode capture
- Profile storage
- Configuration storage with password protection
- Image data file formats in binary (bin), ASCII (img), bmp, jpg, png, tif

### Calibration Functions

- Fully automatic background map correction (pixel-by-pixel) with bias offset
- Automatic background monitor and warning
- Automatic A/D offset/gain set (analog only)
- Optical scale factor (magnification/reduction)
- Far-field optic focal length
- Camera pixel size (horiz. and vert.) (analog only)
- Power/energy calibration factor

### Standard Graphics Feature

- Contour map with profiles/aperture overlay:
  - 3 plot types (contour/2D, 3D, Polar)
  - 4 scaling levels (fixed, scale-to-peak, low intensity, high intensity)
  - 4 style settings (gray, smooth, sharp, shaded bands)
- Live video mode
- Calculation inclusion area display
- Profile/peak/centroid position cursor
- Graphic zoom
- Auto-scale 2D or profile intensity
- Polar beam wander plot
- On/off axis simultaneous display of:
  - Position cursor
  - Cross-section profiles
  - Gaussian fit profiles
  - Reference profiles
  - Aperture overlay for:
    - Beam uniformity
    - % energy/power
- Rotatable color 3D isometric plot
  - 360°, 90° rotate/tilt
  - Hidden/transparent wire
  - Selectable wire density
  - Solid or single color
  - Auto-rotate mode

# Beam Diagnostic Accessories

## Laser-Grade Attenuation Optics for Cameras

Attenuation Optics & Accessories

**Features**

- **Laser-grade attenuation optics**
- **Compatible with all Coherent beam diagnostic cameras**
- **Virtually undistorted and interference-free attenuation**
- **Variable and fixed attenuation for beams up to 2000W/cm² or 50J/cm²**
- **C-Mount threads couple directly to cameras**

Most cameras are too sensitive for direct viewing of laser beams. For example, a typical diagnostics camera saturates at only ~0.5 µW/cm² power density (at ~633 nm) or at ~9 nJ/cm² (at 1064 nm) pulsed energy density. If the camera has an electronic shutter, it can be used for some CW beam attenuation, but there is more flexibility in using optical attenuation. Any attenuation optics introduced in the beam path must be manufactured to exacting specifications. The optics must be laser-grade substrate, and use the proper flatness and wedge to avoid etaloning and fringing, so that the beam is not distorted by the introduction of the attenuation. We offer attenuation optics that are designed to these specifications and packaged for use with our cameras.

Typical attenuations are 1:1 to 400,000:1, but even larger attenuations are possible. All Coherent diagnostic cameras accept C-Mount optics and accessories, and are delivered without a standard window in front of the sensor array. Such windows are liable to distort the optical beam. However, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera purchased from Coherent. The LDFP is a laser-grade optic specified and polished for diagnostics use. It is mounted in a housing with C-Mount threads and provides attenuation of room light so that the camera can be used with the lights on. For operation below 400 nm, the LDFP must be removed.

The Continuously Variable Attenuator Modules (C-VARM and UV C-VARM) contain two wedge attenuators that are continuously variable and a step attenuator that allows attenuation from $10^7$:1 down to 3000:1. The C-VARM and UV C-VARM can be finely adjusted to achieve both precise attenuation levels and maximum use of the camera's optical dynamic range.

The Variable Attenuator Module (VARM) is a triple-wheel filter holder that contains three filters per wheel. The filters are made to our exacting specifications for transmission value and material quality. The VARM is adjustable in attenuation in 64 discrete steps of approximately 16% reduction each time from 400,000:1 down to 1:1. The VARM can be easily returned to exactly the same attenuation level as previously used.

The BeamCUBE™ Fixed-Attenuator Modules (BCUBE and UV-BCUBE) provide fixed attenuation and beam pickoff for performing diagnostics on high-power laser sources. The BCUBE and UV-BCUBE utilize the front surface reflection from an uncoated laser mirror to achieve beam samples at 2% to 10% of the incident radiation, depending upon beam polarization. Multiple BCUBEs can be coupled together for even higher fixed attenuation levels.

# Beam Diagnostic Accessories

## Attenuation Optics for Cameras

BCUBE, UV-BCUBE, VARM, C-VARM, UV C-VARM and all other Coherent cameras have female C-Mount threading, making them easy to connect with the male C-Mount connection flange provided with each attenuator. Also, all attenuators have 1/4-20 tapped holes for independent post or plate mounting.

The C-Mount flanges (threaded rings) also have a female RMS microscope thread. This allows a microscope objective to be coupled to the attenuators and extension barrels in order to create a flexible close-up imaging system for analysis of small/focused beams, fiber optics, laser diodes or LEDs.

VARM, LaserCam-HR-InGaAs, C-VARM, BCUBE, C-Mount Flanges and Barrel

### Avoiding Multi-Filter Beam Distortion

The wavefront distortion through a number of optical filters can be calculated by taking the square root of the sum of the squares of the wavefront distortion of the individual components. For example, if the individual optics are made to λ/10 specifications and six are used, a total λ/4 RMS wavefront distortion will be introduced to the beam:

$$\sqrt{0.1^2 + 0.1^2 + 0.1^2 + 0.1^2 + 0.1^2 + 0.1^2} = 0.25$$

In general, a camera cannot sense less than ~λ/4 total distortion in the beam, so if a series of filters is used, they must be made to very exacting laser-grade specifications. Attenuating optics from Coherent are manufactured to better than a λ/10 surface specification, so at least six optics in series can be used. Calculate the Low-Distortion Face Plate (LDFP) and each BCUBE as one optic, and the VARM or C-VARM as three optics each.

### Attenuator Selection

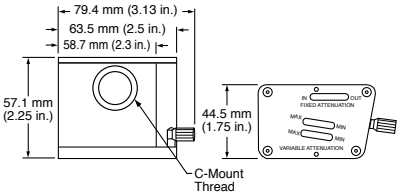
Attenuation is selected on the basis of power density in W/cm² or energy density in J/cm². The attenuation from the camera's Low-Distortion Face Plate (LDFP) will allow an average power density of up to 1.2 mW/cm². There are then only two more steps to attenuation selection:

1) Choose either the VARM or the C-VARM for up to 1W/cm².
2) In addition or alternatively, use a BCUBE beamsplitter module to pick off between 2% and 10% of the beam (depending on polarization and wavelength).

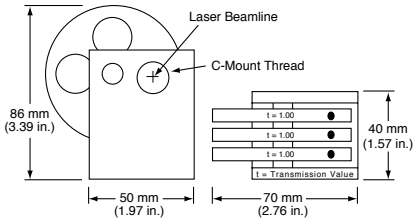
| Device Specifications | Model | VARM | C-VARM | UV C-VARM | BCUBE | UV-BCUBE | BARREL SET (Barrels, 3 C-Mount Flanges) |
|---|---|---|---|---|---|---|---|
| Wavelength | | | | | | | |
| | Min. (nm) | 380 | 380 | 190 | 380 | 190 | – |
| | Max. (nm) | 2200 | 2200 | 1100 | 2200 | 2200 | – |
| Attenuation | | | | | | | |
| | From | $4 \times 10^5$:1 | $10^7$:1 | $10^5$:1 | 50:1 | 50:1 | – |
| | To | 1:1 | 3000:1 | 300:1 | 10:1 | 10:1 | – |
| Aperture (mm) | | 19 | 17 | 17 | 19 | 19 | – |
| Max. Power Density (W/cm²) | | 1* | 1* | 1* | $2.0 \times 10^9$ | $2.0 \times 10^9$ | – |
| Max. Energy Density (J/cm²) | | 0.1* | 0.1* | 0.008 | 50 | 50 | – |
| Damage Limit | | | | | | | |
| | (W/cm²) | $5 \times 10^7$ | $5 \times 10^7$ | – | $2.5 \times 10^9$ | $2.5 \times 10^9$ | – |
| | (J/cm²) | 10 | 10 | 0.008 | 50 | 50 | – |
| Beam Offset (mm) | | – | – | – | 4.0 | 4.0 | – |
| Part Number | | 33-3328-000 | 33-3336-000 | 33-6859-000 | 1098403 | 1098466 | 1098426 |

* The maximum power and energy density listed are the levels at which thermal lensing occurs.

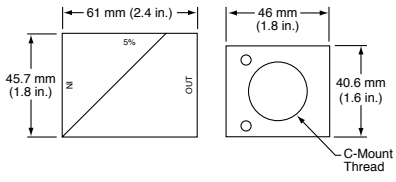
**C-VARM and UV C-VARM**




**VARM**




**BCUBE and UV-BCUBE**



# Beam Diagnostic Accessories

## Extreme-UV Beam Intensity Profiler (BIP) Optics

BIP-5000Z and BIP-12F attached to a LaserCam-HR

BIP-5000SPL Beamsplitter

**Features**

- **UV operation from 10 nm to 355 nm**
- **Choice of 12 mm or 30 x 40 mm diameter apertures**
- **Operation with BeamView Analyzer Systems**

These Extreme-UV Beam Profiler Optics use UV-to-visible fluorescence converter face plates to couple the input laser beam to any appropriate Coherent camera. Any of our visible wavelength range cameras can be used with the Beam Intensity Profilers.

The Beam Intensity Profiler BIP-12F is a compact system accepting beams up to 12 mm in diameter from 10 nm to 355 nm. The front of the BIP-12F has a C-Mount thread, which allows it to be used in conjunction with the UV BeamCube when high-power attenuation is needed for the spectral region 190 nm to 355 nm (see Laser-Grade Attenuation Optics for Cameras on page 68). The Beam Intensity Profiler BIP-5000Z has a zoom magnification range of 6:1 to 1:1 and accepts beams up to 30 mm by 40 mm from 10 nm to 320 nm. It comes with the mount shown.

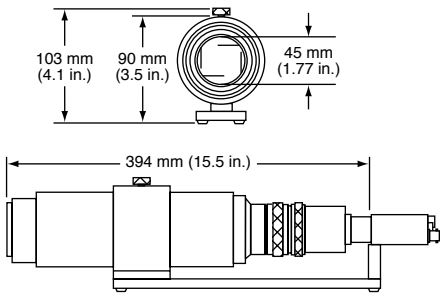
**BIP-5000SPL Beamsplitter**

When laser beam power or energy density exceeds recommended ranges, this beamsplitter provides additional high-power attenuation capability for the BIP-5000Z. It provides a right-angle pick-off function and attaches to the entrance aperture of the BIP-5000Z.

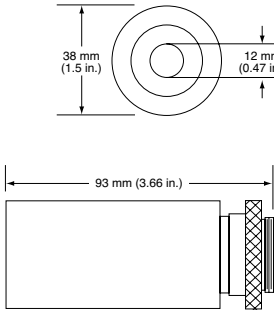
**Device Specifications**

| Model | BIP-12F (2:1) | BIP-12F (1:1) | BIP-5000Z | BIP-5000SPL |
|---|---|---|---|---|
| Wavelength (nm) | 10 to 355 | | 10 to 320 | 10 to 320 |
| Aperture (mm) | Ø12 | | 30 x 40 | Ø50 |
| Resolution (camera-dependent)(µm) | 20 | | 70 | – |
| Saturation | | | | |
| at 193 to 248 nm | 10 mJ/cm² | | 30 mJ/cm² | – |
| at 308 nm | 50 mJ/cm² | | 50 mJ/cm2 | – |
| Sensitivity | 5 µJ/cm² | | 5 µJ/cm² | – |
| Damage Threshold | | | | |
| CW | 5W/cm² | | 1.5W/cm² | 10W/cm² |
| Pulsed | 500 mJ/cm² | | 600 mJ/cm² | 50 J/cm² |
| Uniformity Over Aperture (%) | 5 | | | – |
| Image Persistence (fluorescence lifetime) | 500 ns | | 5 µs | – |
| Image Magnification | 2:1 | 1:1 | 6:1(Zoom) to 1:1 | – |
| Part Number | 33-3468-000 | 1053418 | 33-3484-000 | 33-3492-000 |

**BIP-5000Z**




**BIP-12F**



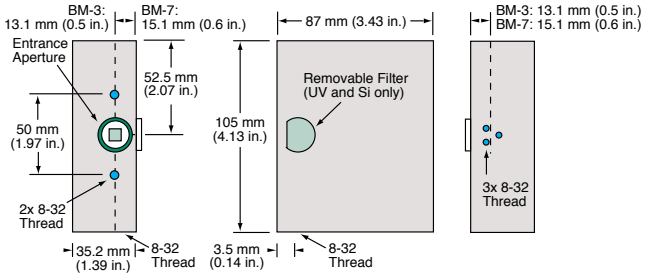
# BeamMaster

## Knife-Edge Beam Profiler

BeamMaster System (rotational mount shown is an option and is not included)

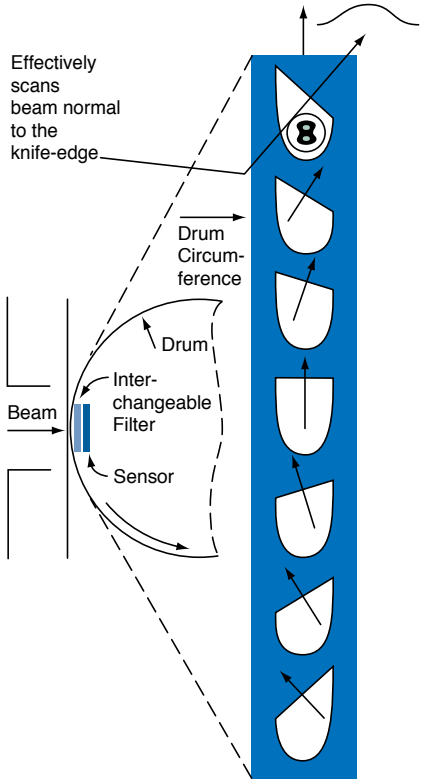
### Features

- CW laser beam shape, power and position measurements
- Beam sizes from 3 µm to 9 mm with 0.1 µm resolution and high dynamic range
- Real-time Windows display, analysis and data logging system
- Wavelengths from 190 nm to 1800 nm




BeamMaster is a high-precision, multiple knife-edge scanning laser beam profiler which can be configured to sample, measure and display cross-sectional profiles and/or 2D and 3D image plots in real time up to 5 Hz. Selectable averaging of 1 to 20 samples provides noise reduction and maximizes measurement accuracy. Data can be collected, displayed, stored and continuously streamed to the RS-232 port. All screen images can be captured and stored, or be printed to any Windows-supported printer.

BeamMaster can measure focused beam spots as small as 3 µm with 0.1 µm resolution and has an aperture as large as 9 mm with 1 µm resolution for larger beams. Measurements can be made from 190 nm to 1100 nm (Si-Enhanced) and from 800 nm to 1800 nm (InGaAs). Input powers can be as low as 10 µW. There is automatic gain control and two internal distortion-free optical attenuation filters are included (Si-Enhanced models)



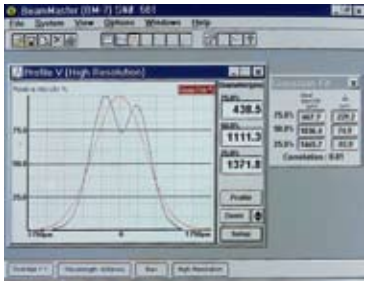

**Multiple Knife-Edges for Greater Resolution and Accuracy**
BeamMaster is an advancement over the more common types of beam profilers, which use two orthogonal knife-edges or slits to scan the beam profile. The BeamMaster model BM-7 uses seven individual knife-edges on a rotating drum to scan the beam through seven different axes in a single rotation. This provides more accurate measurements of the true beam shape and dimensions by tomographically combining the data from all seven scans to reconstruct a profile of the beam. This technique also makes locating the angular orientation of elliptical beam major/minor axes much easier than searching by rotating the sensor head around the optical beam axis. For applications with circular or near-Gaussian beams, the lower-cost BM-3, with only three knife-edges, is also available.

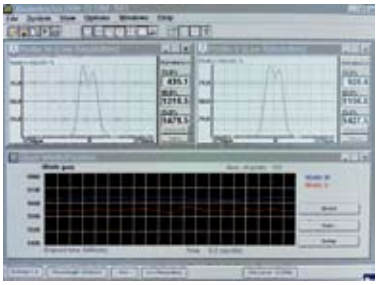
# BeamMaster

## Knife-Edge Beam Profiler



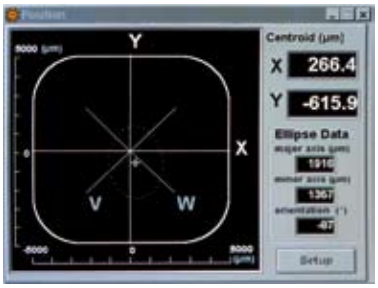
### Beam Profiles and Widths





On each rotation of the drum, BeamMaster captures and processes the data from the passage of the seven knife edges across the beam (three knife edges with BM-3) as power, position and profile information. This information can be displayed every rotation, be strip-charted, and be sent to file or to the RS-232 port. Two orthogonal profiles can be displayed and the beam widths can be digitally displayed for any three user-chosen clip levels. A Gaussian-fit profile can be overlaid on any chosen measured profile and the fit and correlation parameters can be displayed.

To obtain the maximum profile detail, the system automatically centers the profile and zooms to display ~3 times the beam width, and the profile intensity data is autoscaled (optional) to fit the display height. Added detail can be obtained in a special high-resolution mode. This mode is very useful for analyzing beams that are either far from Gaussian in shape or smaller than 100 µm.




### Beam Position and Ellipticity

The beam centroid position can be continuously monitored relative to the center of the sensor area, along with the beam shape, ellipticity (major and minor axes) and angular orientation. A zoom function is available and the user can choose the clip level and strip-chart the position (X and Y) data to monitor short-term or long-term, time-dependent stability or drift.

### Power Measurement

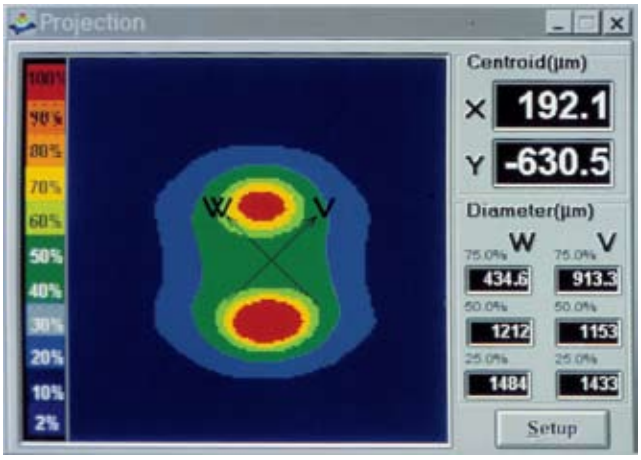
The beam power can be displayed either as a digital readout or in combination with an analog "needle." Units can be chosen as µW, mW or dBm, and the user can offset the zero and zoom in on any part of the power range. Attenuator (filter) files can be selected, and a test range can be selected and displayed to monitor beam power within specific limits, with optional audio alarms.

### Data Collecting and QA Testing

Data regarding beam size, position and power can be continuously displayed in analog, digital and strip chart forms on the computer screen. Data can also be logged to a data file in real time for later processing or test report generation. Pass/Fail testing can be performed on measured results for acceptance within specific tolerances. Files can be transferred to another computer with an RS-232 link or data can be transferred in real time. All screen images also can be captured and stored as BMP or JPG files or can be printed to any Windows printer.

### 2D and 3D Intensity Plots

The projection function provides either a 2D or 3D view of the beam intensity profile. The projection is created using reconstructive tomography. The same method is used to produce 3D images with X-ray systems. The more knife edges, the greater the level of detail that can be obtained. For a beam distribution that is significantly non-Gaussian, such as that from a diode laser, the standard seven-knife-edge system can reconstruct a plot that closely matches the real beam. When examining near-Gaussian beams, the three-knife-edge system gives an accurate intensity distribution.




BeamMaster 2D Intensity Plot

# BeamMaster

## BeamMaster Accessories

The 2D contour maps and the 3D isometric plots can be displayed with or without scan axis and grids, and the isometric plots can be rotated for easier viewing of the detailed structure.

### BeamMaster System Components

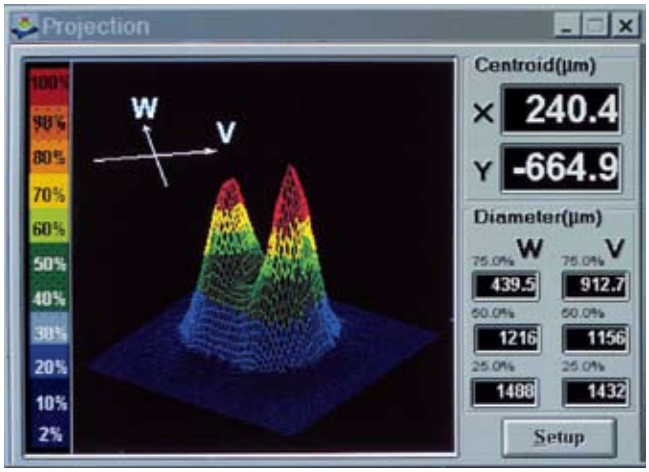
Each BeamMaster system consists of a sensor head, complete with a 1.8 m cable, a 1/2-length (187 mm) 32-bit PCI card to plug into a PC computer, complete Windows software on a CD-ROM disk, a printed instruction manual, a 0.5" mounting post (threaded 8-32), and optical filters (for Si-Enhanced).

### Optical Filters

The BM-7 and BM-3 Si-Enhanced heads come with two neutral density filters. NG4 and NG9 filters (complete with transmission curves) are provided to extend the power range of the heads from 5 mW to 1W in the 400 nm to 1100 nm range. The NG4 filter comes pre-installed and provides ~10% transmission at 633 nm. The NG9 filter is in a protective filter case and provides ~0.5% transmission at 633 nm. There is no filter in the BeamMaster InGaAs head configurations.

### Computer Requirements

The user provides a Pentium PC (586 or higher, 233 MHz) operating Windows 2000 or XP with a free PCI card slot. The system should have 32 megabytes of RAM, a CD-ROM drive, ~20 megabytes of free hard-disk memory, and a display resolution of 800 x 600 or higher.




BeamMaster 2D Intensity Plot

### BeamMaster Accessories

An optional mount is available to enable rotation of the BeamMaster sensor head about the optical axis. This mount has a 360-degree calibrated scale with a locking screw. An optional C-Mount Adapter Plate allows the attachment of any C-Mount, threaded optical accessory, such as a BCUBE high-power attenuator pickoff optic (see the Beam Diagnostics Accessories section on page 68).

**Device Specifications**

| Model | BeamMaster |
|---|---|
| Measurement Rate (Hz) | 5 |
| Wavelength Range (nm) | 190 to 1100 [BM-7 Si-Enhanced, BM-3 Si-Enhanced]<br>800 to 1800 [BM-7 InGaAs (3 or 5 mm), BM-3 InGaAs (3 mm)] |
| Sensor Aperture | 9 mm square [BM-7 (Si-Enhanced)]<br>5 mm circular [BM-3 (Si-Enhanced)]<br>3 mm circular [BM-3 and BM-7 (InGaAs)]<br>(optional BM-7 InGaAs 5 mm available) |
| Minimum Beam Size (µm) | 15 (BM-7 all models)<br>3 (BM-3 all models) |
| Beam Size Resolution | 1 µm for beams >100 µm in size<br>(0.1 µm for beams <100 µm in size) |
| Position Measurement Resolution (µm) | 1 |
| Position Measurement Accuracy (µm) | ±15 |
| Beam Width Measurement Accuracy (%) | ±2 |
| Beam Power Range | 10 µW to 1 W (with supplied internal filters), saturation 0.1 W/cm² without filter, 20W/cm² with NG9 filter<br>[BM-7, BM-3 (Si-Enhanced)] 10 µW to 5 mW (no filters provided), saturation 0.1 W/cm² [BM-3 InGaAs, BM-7 InGaAs] |
| Relative Power Measurement | 0.1 µW resolution |
| Sensor Head Weight (g) | 56 g |
| Part Number | |
| 1037702 | BeamMaster BM-7 Si-Enhanced |
| 1037699 | BeamMaster BM-3 Si-Enhanced |
| 1037710 | BeamMaster Bm-7 InGaAs (3 mm) |
| 1037712 | BeamMaster BM-7 InGaAs (5 mm) |
| 1037708 | BeamMaster BM-3 InGaAs (3 mm) |
| 1038024 | BeamMaster Rotation Mount |
| 33-7147-000 | BeamMaster C-Mount Adapter Plate |
| 1037713 | BeamMaster PCI Upgrade Kit |

# ModeMaster PC

## $M^2$ Beam Propagation Analyzer

**Features**

- **Measurement and display of CW laser divergence, $M^2$ (or k) and astigmatism**
- **Beam sizes 0.2 mm to 25 mm**
- **Wavelengths from 220 nm to 15 µm**
- **Determination of waist location and diameters (including D4σ diameter) and Rayleigh range**
- **Angular and translational beam-pointing stability**

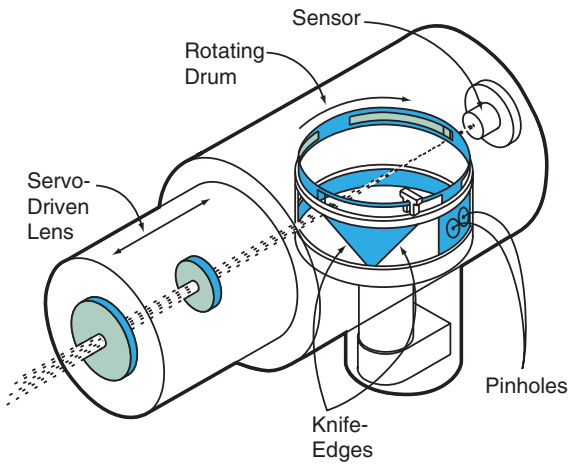
## How Does the ModeMaster PC Work?

The ModeMaster PC head is a dual-knife-edge beam profiler integrated with a diffraction-limited precision scanning lens, which is translated along the beam propagation axis. The lens focuses the beam to create an internal beam waist, and the two orthogonal knife edges (X and Y), which are mounted on a rotating drum, measure the beam diameter and beam axis location at 256 planes along the beam waist as the lens is translated. The powerful ModeMaster PC software then derives the $M^2$ factor, the size and location of the beam waist, the far-field divergence angle, the pointing direction, astigmatism and asymmetry, and the Rayleigh range.

Measurements also include ISO D4σ, second moment, knife-edge, slit and D86 beam diameters. The entire measuring process occurs in less than 30 seconds.

The ModeMaster PC also provides special weighting functions to help eliminate effects on measurement accuracy due to intermittent beam noise, vignetting or other transients during the focus scan. Real-time displays allow laser peaking or adjustment for minimum $M^2$, divergence, maximum power density, far-field pinhole profiles and pointing angle.

## Complete Geometric Beam Characterization Along the Laser Beam Path

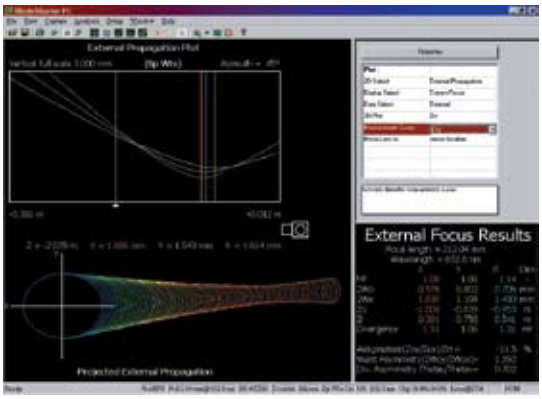



- **Beam Quality – $M^2$**
- **Beam Diameter**
- **Waist Diameter & Location**
- **Divergence Angle**
- **Rayleigh Range**
- **Pointing Stability**
- **Power Density**
- **Beam Profiles**
- **Second-Moment Diameters**
- **Astigmatism**
- **Waist Asymmetry**
- **Divergence Asymmetry**

Beam propagation is concerned with the energy distribution in a beam and the change of that distribution along the beam path. The ModeMaster Beam Propagation Analyzer established a new laser beam quality parameter, $M^2$, which has now become an ISO measurement standard. $M^2$ describes how close to "perfect-Gaussian" a laser beam is, and can be used to predict the beam size, beam shape and the smallest spot that can be created from the beam further downrange.

# ModeMaster PC

## $M^2$ Beam Propagation Analyzer




Beam Propagation Display

Coherent pioneered $M^2$ beam propagation analysis with the ModeMaster system a decade ago. Now, the new ModeMaster PC Laser Beam Propagation Analyzer combines all the ISO-compliant accuracy and powerful features needed for measuring $M^2$ and other beam propagation analysis functions for CW lasers. It also provides the added flexibility and value of a personal computer to provide optimum user control, data processing, storage and results display.

The ModeMaster PC includes a Universal Serial Bus (USB) control/interface console and Windows software for operation with Windows 2000 or XP). The ModeMaster PC is also compatible with all existing ModeMaster systems, allowing legacy ModeMaster system users to easily upgrade their systems for use on a supported PC computer.

## Easy Beam Alignment

The precision 5-axis head mount and beam position display of the ModeMaster PC provide easy angular alignment and translational centering of the lens and scan axis to the beam propagation path.

## Second-Moment Diameters

Beam diameter is a critical parameter in beam propagation measurements. Second-moment diameters ($D4\sigma$) give the best theoretical answers for beam propagation calculations. The ModeMaster PC measures second-moment diameters directly. The ModeMaster PC software also includes conversion algorithms from its knife-edge measurements to second-moment diameter measurements that are valid for stable resonator modes with $M^2$ of 1 to 4 (covering most commercially available lasers). Also included are conversions to D86 and slit diameters to allow comparison to other measurements.

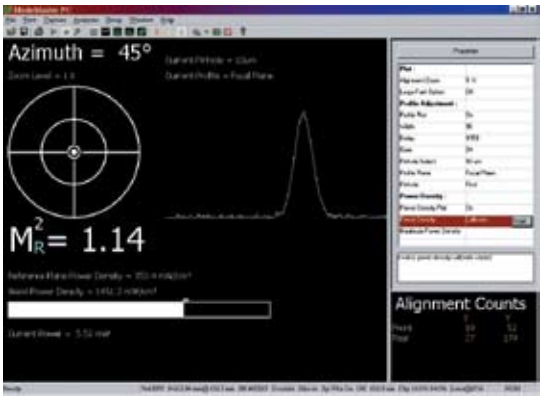
## Real-Time Power Density Adjustment

In most laser applications it is not laser power that does the work but power density. Using the ModeMaster PC, the point of maximum power density can be quickly located. A convenient power density tuning screen displays power density as a pseudo-analog "tune bar," giving real-time feedback as the laser mirrors are adjusted.

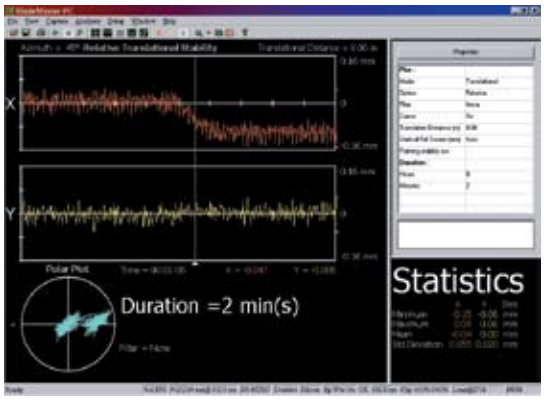
# ModeMaster PC

## M² Beam Propagation Analyzer





Real-Time Display



Pointing-Stability Display

**Real-Time M² and Beam Profiles**
The ModeMaster PC provides real-time measurement and display for fine tuning $M^2$ and many other beam propagation parameters, as well as the near-field or far-field pinhole intensity beam profiles.

**Beam-Pointing and Translational Stability**
ModeMaster is able to measure and display both translational (parallel to the beam axis) or angular (from a pivot point) beam movement over a period of 2 minutes to 24 hours. The angular pivot point of the beam axis (often a single optical surface) can be located along the beam path. Statistical analysis of the beam axis location and angle are displayed for both the X and Y axes. Three levels of filtering reduce noise and increase the sensitivity of pointing-stability measurements.

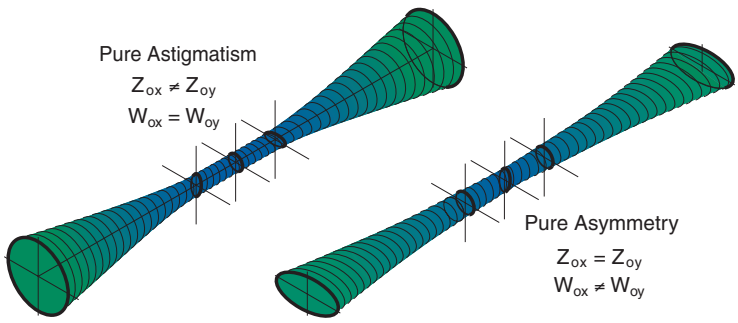
**Expanded Online Help**
The ModeMaster PC provides complete online help. Help messages also suggest corrective measures when beam parameter limits are exceeded.

**Upgrading to the ModeMaster PC**
All previous versions of the ModeMaster systems can be upgraded to the ModeMaster PC. The original console unit and the LabMaster display are simply replaced with the ModeMaster PC Control/Interface Module and Software, installed in a user-supplied compatible PC computer. All original ModeMaster scan heads are fully compatible and can be plugged into the ModeMaster PC Control/Interface Module, which can be ordered separately with the software.

**RS-232 Interface**
The ModeMaster PC can provide measured beam data, analysis results and focus scan control (through the RS-232 interface) for remote data logging, results monitoring and measurement control.

## Beam Astigmatism and Asymmetry

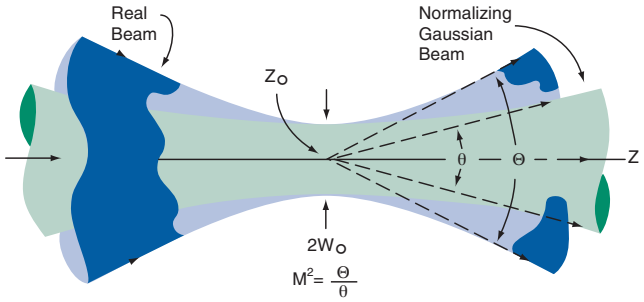
Changes in the shape of a propagating beam can be astigmatic, asymmetric or both. The beam shown at the near right has pure astigmatism; the waists (Wo) in the horizontal and vertical directions are the same size, but occur at different propagation distances (Zo). In asymmetric beams (far right) the two waists occur together, but are of different diameters. The ModeMaster PC provides complete analysis of these beam characteristics.



# ModeMaster PC

## Laser Beam Quality

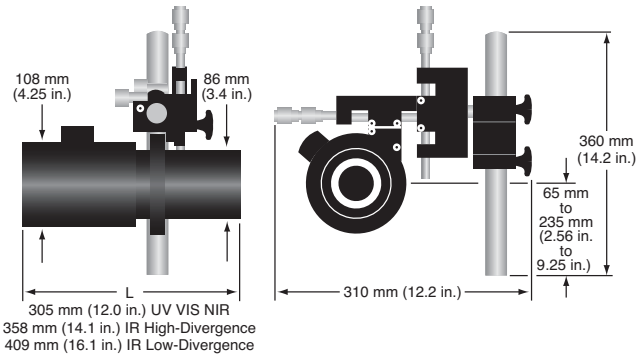
The closer an actual laser beam is to diffraction-limited, the more tightly it can be focused, the greater its depth of field, and the smaller the diameter of the beam optics can be to transmit the beam. $M^2$ is the ratio of the divergence of the actual beam to that of a theoretical diffraction-limited beam of the same waist size in the $TEM_{00}$ mode. Thus, the angular size of the beam in the far field will be $M^2$ larger than calculated for a perfect Gaussian beam.




$\Theta = M^2 \times 2\lambda / (\pi W_o)$, FOR A BEAM WAIST DIAMETER $2W_o$.

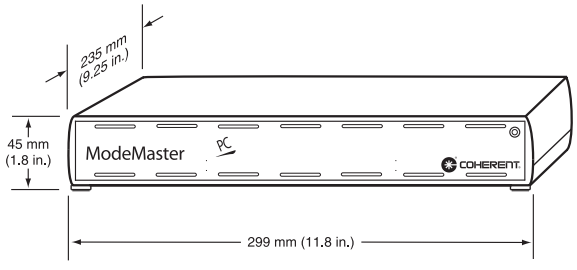
| Device Specifications | Model | ModeMaster PC |
|---|---|---|
| | Accuracies | |
| | Waist Diameter (%) | ±2 |
| | Waist Location | ±8% of input beam Rayleigh Range |
| | Beam Quality – $M^2$ (%) | ±5 |
| | Divergence (%) | ±5 |
| | Beam Translation | ±5% of waist diameter +0.1 mm |
| | Pointing Angle | ±5% of divergence +0.04 mrad |
| | Azimuth Angle Readout | ±2°(10 to 200°) |
| | Knife-Edge Clip Levels | User-adjustable 0% to 100% in 1.5% steps |
| | ModeMaster PC Control/Interface Module Update Rate | <8 Hz ($M^2$, divergence, power density, waist diameter, profiles) |
| | Analog Outputs | Detector signal output, 0 to 13V maximum<br>A/D control signal out, 0 to 5V pulse<br>Trigger (syncs to drum rotation), 0 to 5V pulse |
| | Digital Outputs | RS-232 interface. Front and back knife-edge widths and pinhole profiles available in digitized form via RS-232 |
| | Power | 100 to 240 VAC, 47 to 63 Hz, 40W maximum |

Scan Head and Precision Mount




305 mm (12.0 in.) UV VIS NIR
358 mm (14.1 in.) IR High-Divergence
409 mm (16.1 in.) IR Low-Divergence

Control/Interface Console

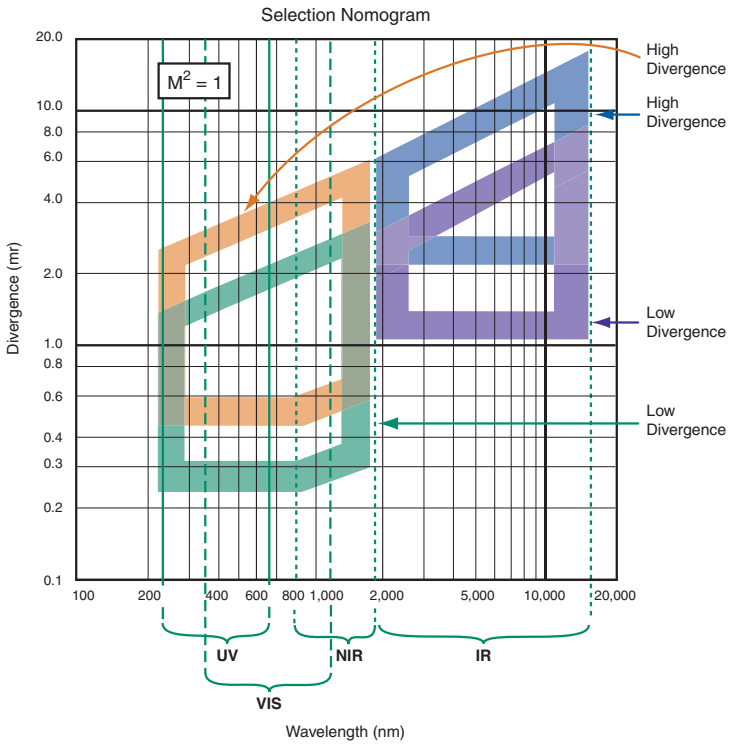


# ModeMaster PC

## Selecting a ModeMaster PC System Configuration



ModeMaster PC systems are available in eight standard configurations (all include scanning head, 5-axis mount, USB control/interface console, cables, PC software and manual). All configurations provide measurements in four wavelength ranges, with two divergence ranges (high-divergence and low-divergence) within each wavelength range. Use the following steps, along with the Selection Nomogram Chart and Configuration Table (below), to select a ModeMaster PC configuration.




1. Choose between the four spectral ranges: UV (220 to 680 nm), VIS (340 to 1000 nm), NIR (800 to 1800 nm) and IR (1800 to 15,000 nm).
2. Determine the approximate divergence of your laser beam and use the Selection Nomogram (Divergence vs. Wavelength) Chart to select the low-divergence or high-divergence configuration.
3. Confirm that your beam size is <25 mm diameter for the low-divergence configuration or <12 mm for the high-divergence configuration.
4. Use the table below to determine the part number of the ModeMaster PC configuration selected, and to verify all other beam specifications.
5. If more than one ModeMaster PC configuration appears to be needed in order to cover all required beam parameter ranges, optional Scanning Head Modular Components can be ordered to change the configuration of the ModeMaster PC system to cover other ranges (see next page for details).

## Standard Configuration

| Name | UV Low-Divergence | UV High-Divergence | VIS Low-Divergence | VIS High-Divergence | NIR Low-Divergence | NIR High-Divergence | IR High-Divergence | IR Low-Divergence |
|---|---|---|---|---|---|---|---|---|
| Model | MM-1 | MM-1S | MM-2 | MM-2S | MM-3 | MM-3S | MM-4 | MM-5 |
| Spectral Range (µm) | 0.22 to 0.68 | | 0.34 to 1.00 | | 0.80 to 1.80 | | 1.80 to 15 | |
| Detector Type | Silicon | | | | Germanium | | Pyroelectric | |
| **INPUT BEAM REQUIREMENTS AT TEST WAVELENGTH** | | | | | | | | |
| Test Wavelength[1] | 351 nm | | 514 nm | | 1.06 µm | | 10.6 µm | |
| Minimum Power[2] | 7.5 mW[3] | | 2.5 mW[3] | | 2.5 mW[3] | | 400 mW | |
| Maximum Power[2] | 10W[3] | | 25W[3] | | 2.5W | | 20W | |
| Noise | <2% RMS and <5% peak-to-peak | | | | | | | |
| Min. Divergence (mrad) | 0.24 | 0.46 | 0.24 | 0.46 | 0.25[5] | 0.47[5] | 2.7 | 1.3 |
| Max. Divergence (mrad)[4] | 1.7 | 3.2 | 2.0 | 3.6 | 2.7 | 5.0 | 14 | 7.2 |
| Max. Beam Diameter (mm)[6] | 25 | 12 | 25 | 12 | 25 | 12 | 12 | 25 |
| Part Number | 33-1843-000 | 33-2106-000 | 33-2221-000 | 33-2239-000 | 33-2387-000 | 33-2395-000 | 33-2429-000 | 33-2437-000 |

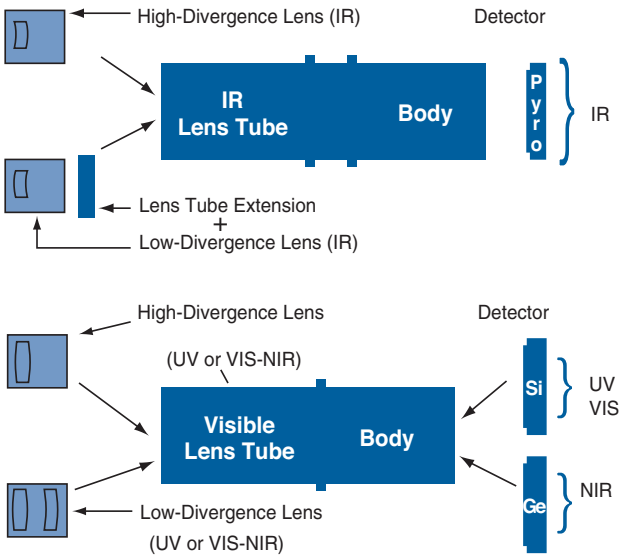
[1] Wavelength-dependent quanlities are input power levels, and minimum and maximum divergence (see Notes 2, 5, 6).
[2] Power levels are proportional to the inverse of the spectral response of the detector. The silicon detector peaks at 900 nm and is at half-peak sensitivity at 510 nm and 1050 nm. The germanium detector peaks at 1500 nm and is at half-peak sensitivity at 1100 nm and 1650 nm. The pyroelectric detector has a flat spectral response.
[3] These limits can be reduced by a factor of 10 (higher sensitivity) by user-removal of the light-restricting aperture in front of the detector.
[4] The maximum divergence limit is fixed by the inability to accurately locate the internal waist when the internal beam diameter growth (over the span of the drum) is too slight. Limits shown are for $M^2 = 1$ and test wavelength; limits scale as the square root of $M^2$ (test wavelength).
[5] Minimum divergence in this wavelength range scales as the square root of $M^2$ (test wavelength).
[6] Diameters are approximate; divergence takes precedence in choosing options. Refer to nomogram.

# ModeMaster PC

## Complete Geometric Beam Characterization Along the Laser Beam Path

**Components for Other Wavelength and Divergence Ranges**
The body design of the ModeMaster PC scanning head has modular lens and detector sets that allow quick changes to other wavelength or divergence ranges to meet your measurement needs.

The IR body can only be used with the IR (pyroelectric - pyro) detector and either the low-divergence or high-divergence IR heads. The UV-VIS-NIR body, however, can be used in any of the UV, VIS or NIR spectral regions with the appropriate detector (silicon-Si for the UV and VIS; germanium-Ge for the NIR) and low- or high-divergence lenses. The UV lens can be used with the silicon detector and the VIS-NIR lens can be used with either the silicon or germanium detector.




| Part Number | Description | Spectral Region(s) | Scan Head Body |
|---|---|---|---|
| 33-2072-000 | Silicon Detector (0.22 to 1.0 µm) | UV, VIS | UV-VIS-NIR |
| 33-2080-000 | Germanium Detector (0.8 to 1.8 µm) | NIR | UV-VIS-NIR |
| 33-2098-000 | Pyroelectric Detector (1.8 to 20 µm) | IR | IR |
| 33-2114-000 | High-Divergence Lens Kit | UV | UV-VIS-NIR |
| 33-2130-000 | Low-Divergence Lens Kit | UV | UV-VIS-NIR |
| 33-2122-000 | High-Divergence Lens Kit | VIS, NIR | UV-VIS-NIR |
| 33-2148-000 | Low-Divergence Lens Kit | VIS, NIR | UV-VIS-NIR |
| 33-2155-000 | High-Divergence Lens Kit | IR | IR |
| 33-2166-000 | Low-Divergence Lens Kit | IR | IR |

## ModeMaster PC $M^2$ Beam Propagation Analyzer (standard system configuration)

| Part Number | Description | Spectral Range |
|---|---|---|
| 33-1843-000 | ModeMaster PC System[1] | UV, Low-Divergence |
| 33-2106-000 | ModeMaster PC System[1] | UV, High-Divergence |
| 33-2221-000 | ModeMaster PC System[1] | VIS, Low-Divergence |
| 33-2239-000 | ModeMaster PC System[1] | VIS, High-Divergence |
| 33-2387-000 | ModeMaster PC System[1] | NIR, Low-Divergence |
| 33-2395-000 | ModeMaster PC System[1] | NIR, High-Divergence |
| 33-2437-000 | ModeMaster PC System[1] | IR, Low-Divergence |
| 33-2429-000 | ModeMaster PC System[1] | IR, High-Divergence |
| 33-1710-000 | ModeMaster PC Control/Interface Console and Software | – |

[1] All ModeMaster systems include scan head, mount, control/interface console and software.

# WaveMaster

## Laser Wavelength Meter

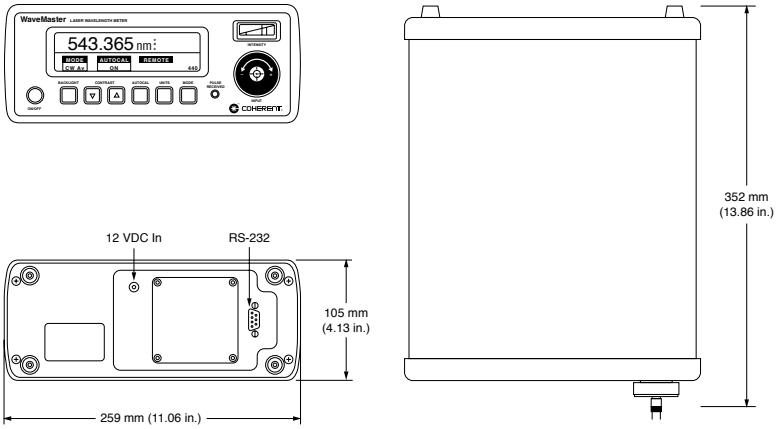
### Features

- 380 nm to 1095 nm wavelength range
- RS-232 interface
- Internal self-calibration
- Fiber input with sampling probe

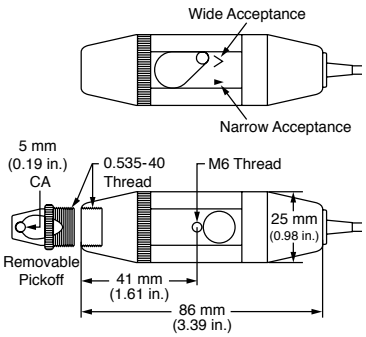
**Device Specifications**

| Model | WaveMaster |
|---|---|
| Wavelength Coverage (nm) | 380 to 1095 |
| Accuracy (nm) | 0.005 |
| Resolution (nm) | 0.001 |
| Minimum Pulse Rep. Rate | Single shot |
| Maximum Pulse Rep. Rate | CW |
| Maximum Signal Bandwidth (nm) | 2 at 400<br>3 at 600<br>5 at 1000 |
| Minimum Signal | 20 µW CW at 632 nm<br>2 mJ pulsed at 1064 nm |
| Maximum Signal | 100 mW CW at 632 nm<br>100 mJ pulsed at 1064 nm |
| Display Update (Hz) | 3 |
| Size (W x H x D) (mm) | 259 x 105 x 352 |
| Storage | |
| Storage Condition | -10°C to 50°C (14°F to 122°F) |
| Relative Humidity | Non-condensing and <80% |
| Shock (g) | >4 |
| Use Conditions | -10°C to 40°C (14°F to 104°F) |
| Relative Humidity | Non-condensing and <80% |
| Shock (g) | <4 |
| Power Supply (included) | Universal 90 to 250 VAC;<br>40 to 72 Hz in; 12 VDC out |
| Part Number | 33-2650-000 |

WaveMaster




Sampling Probe



# WaveMaster

## Laser Wavelength Meter

The WaveMaster measures the wavelength of both CW and pulsed lasers of any repetition rate. The wavelength can be displayed in GHz, wave numbers, or nanometers, with vacuum and air readings available. The WaveMaster will read the peak wavelength of sources as wide as 2 nm from 380 nm to 1095 nm. Bandwidths wider than 2 nm can be accommodated at the longer wavelengths.

The WaveMaster is easy to use. Just turn on the readout and get the beam within 10 degrees of normal incidence to the sampling probe. The probe has a 2-meter fiberoptic cable and takes up a minimum of beam path space. Most intensity variances are automatically accommodated, but for the strongest and weakest signals a front panel attenuator adjustment and intensity readout quickly produce accurate readings. No special triggering modes or setups are required for pulse capture.

**User-Friendly**
The WaveMaster is easy to read with front panel adjustments of contrast and back-lighting for the extra-large display. Parameters that have been set-up are clearly displayed, in addition to signal intensity and pulse-retrieved indicators. Configuration settings are maintained in memory and retrieved on start-up for convenience. Communication with the WaveMaster is also easy with a built-in RS-232 port.

Sophisticated algorithms that monitor the WaveMaster's response maintain calibration. Periodically, and upon indication from the algorithms, the WaveMaster is referenced to the fundamental lines of an internal NE source.

**Pulse or CW Operation**
The operational mode can be changed from CW, to CW with averaging, to pulse. In CW mode the display is updated at 3 Hz. In CW with averaging, the display is updated at 3 Hz with an average of the last 10 readings taken at 3 Hz. For pulse mode, when a valid pulse is received the display will show the wavelength reading of the pulse for 15 seconds, or until another valid pulse is received.

**No Warm-Up Time**
When the WaveMaster is first powered on, it will perform a self-test cycle and then enter the auto-calibration mode. After 10 seconds, the AUTOCAL message is cleared from the display and the WaveMaster is ready to make measurements.

**Accurate**
With its self-monitoring algorithms and an internal spectral line source, the WaveMaster auto-calibrates the internal spectrometer to maintain accuracy.

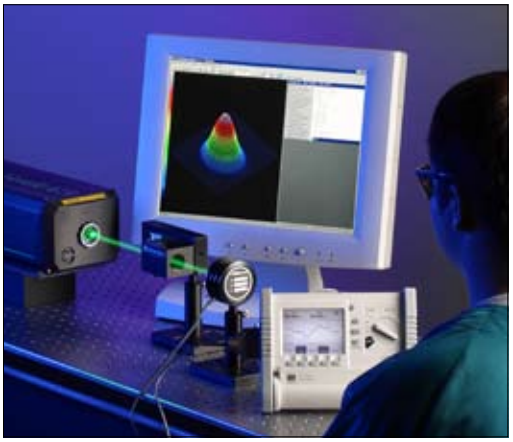
**Easy Set-Up**
Feedback from the WaveMaster is straightforward. Once the signal is applied to the probe, the unit begins sampling to simplify set-up. In CW mode, the WaveMaster will auto-range to adjust the sensor integration time to match the incoming signal. This allows the quickest set-up and greatest versatility.

**Selected Display Units**
The wavelength readings can be displayed in nanometers in "air" at standard temperature and pressure (STP), or shown as a calculated conversion from STP to nanometers in a "vacuum", or displayed as wave numbers ($cm^{-1}$), or as frequency (GHz).

# Calibration and Service

## Certification





**Calibrate Equipment to Maximize Longevity**
Laser power and energy meters from Coherent are precision instruments, capable of delivering very accurate measurements during many years of useful service. To maintain this high level of performance and to ensure compliance with your ISO certification, it is important to have your measurement system serviced and recertified once a year. Extended use of laser power and energy meters, as well as local environmental factors, can have an adverse effect on accuracy and also result in wear and damage to parts critical to optimum performance.

**Recertify Once a Year**
To optimize performance and longevity, and to remain compliant with ISO requirements, Coherent recommends that power/energy meters and sensors be recertified at least once a year.

**We Provide Certification**
Our investment in service and calibration facilities and personnel is ongoing, and we strive to maintain our unique technological edge. Our Quality Management System is registered to ISO 9001:2000, our products are NIST-traceable, and our calibration labs meet the requirements of ANSI Z540.

Our Calibration Lab has a full spectrum of light sources from 193 nm to 10,600 nm with powers ranging from nanowatts to kilowatts. By duplicating the actual environment of the user, we can calibrate, verify and certify all laser power/energy meters.

**Obtaining Warranty Service**
In order to arrange for warranty service or annual recalibration, contact your closest Coherent service center to obtain a Return Material Authorization (RMA) number (see next page).

**Initial Evaluation**
When you return equipment to Coherent for calibration, each device is given a thorough initial evaluation to determine if it can be calibrated adequately in its "As Received" condition.

**Repair and Calibration**
At times we may find it necessary to repair the device before the final calibration can take place. If any problems are identified, or if repairs will result in additional charges, you will be contacted by a Customer Service representative. Only then will we calibrate and recertify your equipment in our labs.

**Reporting Results**
Returned equipment is accompanied by a Calibration Certificate including Before and After results for sensors, and a data report.

# Calibration and Service

## Warranty

**Limited Warranty**
Coherent, Inc., warrants to the original purchaser that its laser power and energy meters and sensors are free from defects in materials and workmanship and comply with all specifications, active at the time of purchase, for a period of twelve (12) months. Coherent, Inc., will, at its option, repair or replace any product or component found to be defective during the warranty period. This warranty applies only to the original purchaser and is not transferable.

**Extended Warranty**
Coherent, Inc., offers original purchasers of laser power and energy meters and sensors an extended twelve month warranty program, which includes all parts and labor. In order to qualify for this warranty, a Customer must return the Product to the Company for recalibration and recertification. The Company will recertify the Product, provide software upgrades, and perform any needed repairs, and recalibrate the Product, for a fixed service fee. If the Product fails and is returned to the Company within one year following the date of recalibration and recertification service, the Company will, at its option, repair or replace the Product or any component found to be defective.

Contact Coherent or visit www.Coherent.com/LMC for additional details and warranty limitations.

**Obtaining Warranty Service**
In order to arrange for warranty service or annual recalibration, first contact your closest Coherent service center to obtain a Return Material Authorization (RMA) number.

**USA**
Phone: 800 343 4912
Fax: 503 454 5727
E-mail: LMC.sales@coherent.com

**Asia**
Phone: 813 5635 8680
Fax: 813 5635 8681
E-mail: LMC.sales@coherent.com

**Europe**
Phone: 49 6071 9680
Fax: 49 6071 968499
E-mail: LMC.sales@coherent.com

Detailed instructions for preparing and shipping your instrument can be found below.

## Instructions for Returning Equipment for Service and Calibration

To prepare your instrument, meter or sensor for return to Coherent, attach a tag to the unit that includes the name and address of the owner, the contact individual, the serial number, and the RMA number you received from Customer Service.

Wrap the product with polyethylene sheeting or equivalent material. If the original packing material and carton are not available, obtain a corrugated cardboard shipping carton with inside dimensions that are at least 6 in. (15 cm) taller, wider, and deeper than the product. The shipping carton must be constructed of cardboard with a minimum 375 lbs. (170 kg) test strength. Cushion the instrument unit in the shipping carton, using 3 in. (7.5 cm) of packing material or urethane foam on all sides, top, bottom, and between the carton and the instrument or sensor. Seal the shipping carton with shipping tape or an industrial stapler.

Shipping addresses for our repair and calibration facilities are given below:

**USA**
Coherent Laser Measurement
and Control Service Center
Attn: (your RMA number)
27650 SW 95th Avenue
Wilsonville, OR 97070
USA

**Europe**
Coherent (Deutschland) GmbH
Dieselstr. 5b
D-64807 Dieburg
Germany

**Asia**
Coherent Japan
Toyo MK Building
7-2-14 Toyo
Koto-Ku, Tokyo
135-0016 Japan

# Measurement Products for Use with Coherent Lasers

## Matrix of Recommendations*



| $CO_2$ (Diamond) Lasers | Laser | Wavelength (µm) | Power Meter | Power Sensor |
|---|---|---|---|---|
| | C-30 | 10.6 | FieldMaxII-TO | PM30 |
| | C-40, C-55, C-70 | 10.6 | FieldMaxII-TO | PM150 |
| | G-100, G-150 | 10.2 to 10.7 | FieldMaxII-TO | PM150 |
| | G-100i | 9.4 ±0.3 | FieldMaxII-TO | PM150 |
| | K-250, K-225i, K-300 | 10.4 to 10.8 | FieldMaxII-TO | PM300F-19 |
| | E-400, K-500 | 10.2 to 10.8 | FieldMaxII-TO | PM1K |
| | GEM Select 50, 100 | 10.6 nominal | FieldMaxII-TO | PM150 |
| | EOM-10 | 10.6 | FieldMaxII-TO | PM10 |
| | MID-IR-2 | 4.6 | FieldMaxII-TO | PM10 |
| | SIFIR | 40 to 1020 | FieldMaxII-TO | PS10 |

| Diode Lasers | Laser | Wavelength (nm) | Power Meter | Power Sensor |
|---|---|---|---|---|
| | CUBE | 375 to 785 | FieldMaxII-TO | PS10 |
| | Radius | 375 to 635 | FieldMaxII-TO | PS10 |
| | All Laser Diode Modules | | FieldMaxII-TO | PS10 |
| | FAP | 780 to 840 | LabMax-TOP | LM-150FS + SMA adapter |
| | Duo FAP | 785 to 820 | LabMax-TOP | LM-150FS + SMA adapter |
| | Quattro FAP | 790 to 980 | LabMax-TOP | LM-150FS + SMA adapter |
| | HighLight 4000L | 805 to 940 | FieldMaxII-TO | PM5K-100 |
| | HighLight 1000F | 975 | FieldMaxII-TO | PM1K |

| Diode-Pumped Solid-State Lasers (CW) | Laser | Wavelength (nm) | Power Meter | Power Sensor |
|---|---|---|---|---|
| | Azure | 266 | FieldMaxII-TO | PM10X or PS10[1] |
| | Compass 1064 | 1064 | FieldMaxII-TO | PM10 |
| | Compass 115M, 215M, 315M | 532 | FieldMaxII-TO | PS10 |
| | Compass 561 | 561 | FieldMaxII-TO | PS10 |
| | Genesis | 355, 532 | FieldMaxII-TO | PS10 |
| | MBD 266 | 266 | FieldMaxII-TO | PM10X or PS10[1] |
| | Paladin 355 | 355 | FieldMaxII-TO | PM10X |
| | Sapphire 460, 488 | 460, 488 | FieldMaxII-TO | PS10 |
| | Sapphire 488 HP | 488 | FieldMaxII-TO | PM10 or PS10[1] |
| | Sapphire 561 | 561 | FieldMaxII-TO | PS10 |
| | Verdi V2, V5, V6, V8 | 532 | FieldMaxII-TO | PM10 |
| | Verdi V10, V12, V18 | 532 | FieldMaxII-TO | PM30 |
| | Verdi IR | 1064 | FieldMaxII-TO | PM30 |

| Diode-Pumped Solid-State Lasers (Pulsed) | Laser | Wavelength (nm) | Power Meter | Power Sensor | Energy Meter | Energy Sensor |
|---|---|---|---|---|---|---|
| | AVIA (<10W) | 266, 355 | FieldMaxII-TO | PM10X | - | - |
| | AVIA (10W to 30W) | 355, 532 | FieldMaxII-TO | PM30X | - | - |
| | AVIA (>30W) | 532 | FieldMaxII-TO | PM150 | - | - |
| | Indigo-DUV | 193 | FieldMaxII-TO | PS10 | 3sigma | J-10MT-10KHZ |
| | Indigo-S | 193 to 900 | FieldMaxII-TO | PS10 | 3sigma | J-10MT-10KHZ |
| | MATRIX 1064 | 1064 | FieldMaxII-TO | PM10 | - | - |
| | MATRIX 355 | 355 | FieldMaxII-TO | PM10X | - | - |
| | PRISMA (<10W) | 532, 1064 | FieldMaxII-TO | PM10 | - | - |
| | PRISMA (>10W) | 532, 1064 | FieldMaxII-TO | PM30 | - | - |
| | Talisker | 355, 532, 1064 | FieldMaxII-TO | PM30 | - | - |
| | Vector | 532, 1064 | FieldMaxII-TO | PM10 | - | - |

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 89). Contact factory for more details.

[1] For these lasers, the PS10 can be selected for users who are looking for either higher resolution or low power measurements.

# Measurement Products for Use with Coherent Lasers

## Matrix of Recommendations*

| Ion Lasers | Laser | Wavelength (nm) | Power Meter | Power Sensor |
|---|---|---|---|---|
| | Innova (<1W) | 200 to 1100 | FieldMaxII-TO | PS10 |
| | Innova (>1W) | 200 to 1100 | FieldMaxII-TO | PM10 |

| Q-Switched Lasers | Laser | Wavelength (nm) | Power Meter | Power Sensor | Energy Meter | Energy Sensor |
|---|---|---|---|---|---|---|
| | Evolution (<30W) | 527 | FieldMaxII-TOP | PM30 | LabMax-TOP | J-25MT-10KHZ plus medium heat sink |
| | Evolution (>30W) | 527 | FieldMaxII-TOP | PM150 | | |

| Ultrafast Amplifiers | Laser | Wavelength | Power Meter | Power Sensor | Energy Meter | Energy Sensor |
|---|---|---|---|---|---|---|
| | OPerA Solo | 240 nm to 20 µm | FieldMaxII-TOP | PS10/PM10 | LabMax-TOP | J-10MT-10KHZ (<1 mJ pump) J-10MB-HE (>1 mJ pump) |
| | TOPAS | 240 nm to 20 µm | FieldMaxII-TOP | PS10/PM10 | LabMax-TOP | J-10MT-10KHZ (<1 mJ pump) J-10MB-HE (>1 mJ pump) |
| | OPA 9400, 9800, DFG | 480 nm to 10,000 nm | FieldMaxII-TOP | PS10/PM10 | - | - |
| | Legend (<10W) | 775 nm to 845 nm | FieldMaxII-TOP | PS10/PM10 | LabMax-TOP | J-25MT-10KHZ |
| | Legend (>10W) | 800 nm | FieldMaxII-TOP | PM30 | LabMax-TOP | J-25MT-10KHZ plus medium heat sink |
| | Libra | 800 nm | FieldMaxII-TOP | PM10 | LabMax-TOP | J-25MT-10KHZ |
| | RegA | 770 nm to 850 nm | FieldMaxII-TOP | PS10 | - | - |
| | Hidra | 800 nm | FieldMaxII-TOP | PM10V1 | FieldMaxII-TOP | J-50MT-10KHZ |

| Ultrafast Oscillators | Laser | Wavelength (nm) | Power Meter | Power Sensor |
|---|---|---|---|---|
| | Mantis | 800 | FieldMaxII-TOP/LabMax-TOP | PM10 or PS10[2] |
| | Micra | 750 to 860 | FieldMaxII-TOP/LabMax-TOP | PM10 or PS10[2] |
| | Mira | 700 to 980 | FieldMaxII-TOP/LabMax-TOP | PM10 |
| | Vitesse | 800 | FieldMaxII-TOP/LabMax-TOP | PM10 or PS10[2] |
| | Chameleon | 680 to 1080 | FieldMaxII-TOP/LabMax-TOP | PM10 |
| | Mira OPO | 500 to 1600 | FieldMaxII-TO | PS10 |

| Excimer Lasers | Laser | Wavelength (nm) | Power Meter | Power Sensor | Energy Meter | Energy Sensor |
|---|---|---|---|---|---|---|
| | BraggStar | 193, 248 | FieldMaxII-TO | PM10X | LabMax-TOP | J-25MT-10KHZ |
| | COMPexPro F2 | 157 | FieldMaxII-TO | PM10X | FieldMaxII-TOP | J-25MUV-193 |
| | COMPexPro 50, 102, 110, 201, 205 | 193 | FieldMaxII-TO | PM150-50XC | FieldMaxII-TOP | J-50MUV-193 |
| | COMPexPro 50, 102, 110, 201, 205 | 248 | FieldMaxII-TO | PM150X | FieldMaxII-TOP | J-50MUV-248 plus large heat sink |
| | COMPexPro 102, 110, 201, 205 | 308, 351 | FieldMaxII-TO | PM150X | FieldMaxII-TOP | J-50MB-YAG |
| | ExciStar XS 200 | 157, 193 | FieldMaxII-TO | PM10X | FieldMaxII-TOP | J-25MUV-193 |
| | ExciStar XS 200 | 248, 351 | FieldMaxII-TO | PM10X | FieldMaxII-TOP | J-25MUV-248 |
| | ExciStar XS 500 | 157, 193, 248, 351 | FieldMaxII-TO | PM10X | LabMax-TOP | J-25MT-10KHZ |
| | IndyStar | 193, 248 | FieldMaxII-TO | PM30X | LabMax-TOP | J-25MT-10KHZ plus small heat sink |
| | LPFpro 205, 220 | 157 | FieldMaxII-TO | PM150-50XC | FieldMaxII-TOP | J-50MUV-193 |
| | LPXpro 210, 220, 305 | 193, 248, 308, 351 | FieldMaxII-TO | PM150X, PM150-50XC | - | - |
| | Xantos XS | 157, 193, 248, 351 | FieldMaxII-TO | PM10X | LabMax-TOP | J-25MT-10KHZ |
| | LAMBDA SX-Series | 248, 308 | FieldMaxII-TO | PM300F-50X PM1KX1 | - | - |

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 89). Contact factory for more details.

[1] For these lasers, the PS10 can be selected for users who are looking for either higher resolution or low power measurements.

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# Notes

# Doing Business with Coherent

### Ordering
We are pleased to accept orders online at www.Coherent.com, or by phone, fax, e-mail or mail. When confirming an order that has been placed, please indicate "confirming" on the order.

### Pricing
Prices are FOB Portland, OR, and do not include freight, duty or any applicable taxes.

Please consult your local Sales Office or Distributor for export prices.

### Coherent Family Plan
Customers who have purchased a Coherent laser valued at greater than US $5.0K within the past 12 months are entitled to a 20% discount on Coherent laser measurement products.

### Terms of Payment
Acceptable terms of payment for domestic orders include cash with order, major credit card, C.O.D. or Net 30 with prior approval of credit.

Export terms are strictly letter of credit, cash in advance or major credit card.

### Shipping
Shipment means are at the discretion of Coherent, but we will attempt to meet your special requests. We do not take responsibility for any delays or damage caused by the shipper.

### Returns
Returns are accepted only after a return authorization number has been obtained from Coherent, and credit will be allowed for items returned under authorization in good condition.

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Cancellation of orders will incur a termination charge of not less than 10% of the order value, and Coherent reserves the right to charge for all costs incurred in support of any cancelled order.

### Warranty
Goods are warranted to be free from defects and to work in the manner specified for a period of 12 months from date of shipment. See page 83 for further warranty details.

### Specifications
Specifications are current at the time of publication, but Coherent reserves the right to change these specifications at any time. Refer to www.Coherent.com for the most current product specifications.

### Terms and Conditions of Sale
Terms and Conditions of Sale are specific to each country in which Coherent operates. They are supplied with all quotations and invoices and can be sent by fax or mail on request. Nothing in the foregoing statements modifies the Terms and Conditions in effect for each country of operation.

### RoHS Compliance
The majority of products in this catalog are RoHS compliant. For more information on specific products, please contact a Coherent Sales Office or Representative.

COHERENT

**Coherent, Inc., Corporate Headquarters**
5100 Patrick Henry Drive
Santa Clara, CA 95054

**United States**
Coherent, Inc., Portland
27650 SW 95th Avenue
Wilsonville, OR 97070
United States
Toll Free: 1-800-343-4912
Tel: (408) 764-4042
Fax: (503) 454-5727
www.Coherent.com

**China**
Coherent, Inc., Beijing
Room 215 Yin Gu Building
No. 9 Beisihuan Xi Road
Haidian District
Beijing, 100080, China
Tel: +86-10-6280-0209
Fax: +86-10-6280-0129
www.Coherent.com.cn

**France**
Coherent France
Domaine Technologique de Saclay
Bâtiment Azur
4, Rue René Razel
91892 Orsay Cedex
France
Tel: +33-1-69-85-51-45
Fax: +33-1-60-19-40-00
www.Coherent.fr

**Germany**
Coherent GmbH
Dieselstraße 5b
D-64807 Dieburg
Germany
Tel: +49-6071-968-333
Fax: +49-6071-968-499
www.Coherent.de

**Italy**
Coherent Italia
Via Borgese, 14
Milano, 20154
Italy
Tel: +39-02-34-530-214
Fax: +39-02-34-934-165
www.Coherent.it

**Japan**
Coherent Japan, Inc.
Toyo MK Building
7-2-14 Toyo
Koto-ku, Tokyo 135-0016
Japan
Tel: +81 3-5635-8680
Fax: +81 3-5635-8701
www.Coherent.co.jp

**Korea**
Coherent Korea
No. 101, Eagle Town
278-20, 3 dong
Seongsu 2 ga
Seongdong-gu, Seoul
133-832, South Korea
Tel: +82 2 460 7900
www.Coherent.com

**Netherlands**
Coherent B.V.
Smart Business Park
Kanaalweg 18A
3526 KL Utrecht
Netherlands
Tel: +31-30-280-6060
Fax: +31-30-280-6077
www.Coherent.nl

**United Kingdom**
Coherent UK Ltd.
St Thomas' Place
Cambridgeshire Business Park
Ely
CB7 4EX
United Kingdom
Tel: +44-1353-658-833
Fax: +44-1353-659-110
www.Coherent.com

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